Essays in alternative investments

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Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

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PROEFSCHRIFT

ter verkrijging van de graad van doctor aan Tilburg University op gezag van de rector magnificus, prof. dr. Ph. Eijlander, in het openbaar te verdedigen ten overstaan van een door het college voor promoties aangewezen commissie in de aula van de Universiteit op maandag 19 september 2011 om 14.15 uur door

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geboren op 14 augustus 1982 te Sint-Niklaas, België.

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Acknowledgements

I would like to thank the different members of my dissertation committee. Rachel's feedback and support has been very helpful since when she first invited me to her art markets conference in Maastricht in 2007. Fabio, Rik, and Frans have always been willing to read my work, and have provided many insightful suggestions over the years. Elroy and Will are great co-authors and wonderful mentors. I am honored that they have taken an interest in my research and in my personal development; this thesis has benefited enormously from my interaction with them. Finally, I am very grateful to Luc, who has been an amazing supervisor throughout my PhD. Despite his many other responsibilities, he always found time to work on our joint projects. His continuous stream of suggestions and ideas has made me a more productive and ambitious scholar than I ever thought I could be. I am deeply indebted to Luc's efforts whenever I needed help in getting data, visiting a university abroad, or finding a job. I am looking forward to continuing our collaboration over the next years.

I very much enjoyed being part of the Finance department at Tilburg University, and I will surely miss the nice colleagues and critical peers. Special thanks to Frank for heading the department—and for not throwing me out of the building after my laptop was stolen in Madrid. I am happy that Peter and Radomir agreed to be paranymphs at my defense. Furthermore, I would like to thank the administrative staff both at the department and at CentER. I am also grateful to the Netherlands Organisation for Scientific Research (NWO) for labeling me a "toptalent", and for providing the funding for this PhD.

Yet, this thesis has been written in many different places. I would like to thank London Business School, Columbia Business School, and the International Center for Finance at Yale University for their warm hospitality. I appreciate Julian Franks' and Geert Bekaert's willingness to be my "sponsors" in London and New York. During research visits and conferences, I took pleasure in talking about art and finance with Noah Horowitz, James Goodwin, David Chambers, Kim

Oosterlinck, Samuel Lee, Juanita Gonzalez, Matt Spiegel, Martijn Cremers, Stefan Hunt, Dasol Kim, Bige Kahraman, and many others. Lastly, I thank the two finance departments at Ghent University, for employing me as a research and teaching assistant prior to my PhD, and for always making me feel welcome even after I had left for Tilburg.

***

My time as a PhD student surely would have been much less fun without my friends. Every day again, they show that the best social networks are not found online. In contrast, they span very offline places like Contamine-Sarzin, Gits, Hoegaarden, Lokeren, and Lovendegem. Extra hat tips to those who visited me in London or New York. I also would like to thank my parents for their continuous support, and my little brother and sister for not holding back in making fun of me.

***

One more person deserves a special word of gratitude. I am a lucky man to have had Veerle on my side throughout the past few years. Her love and encouragement have been an amazing source of energy that enabled me to spend so much time and effort on this thesis. After my multiple stays abroad, I can also safely say that it is “so much better when we’re together”. Or to quote a Belpop classic: “Wat is kunst? Wat is kunst? Die blik in haar ogen, dat is kunst.”

Christophe Spaenjers

Ghent and Tilburg, summer 2011

Summary

This dissertation contains seven chapters. Chapter 1 serves as a general introduction to the risks and returns of collectibles, and is co-authored with Elroy Dimson. Chapter 2 investigates the long-term investment performance of art, and is co-authored with Luc Renneboog. Chapter 3, also written with Luc Renneboog, looks into the returns and return determinants for Russian art. The article has been published in the *Journal of Alternative Investments* (Vol. 13, No. 3, pp. 67–80). Chapter 4 examines the impact of equity markets and the income distribution on art prices, and was written together with William Goetzmann and Luc Renneboog. A shorter version of the chapter has been published in the 2011 AEA Papers and Proceedings issue of the *American Economic Review* (Vol. 101, No. 3, pp. 222–226). Chapter 5 documents how art prices are not only impacted by global economic growth and stock market trends, but also by country-specific factors. Chapter 6 investigates the long-run returns on British collectible postage stamps, and is joint work with Elroy Dimson. The paper has been published in the *Journal of Financial Economics* (Vol. 100, No. 2, pp. 443–458). Chapter 7 concludes and suggests a number of avenues for future research.

Table of contents

Chapter 1

Introduction: The investment performance of collectibles

In 1796, the shell of a *Carinaria Cristata*, a type of sea snail also called “Glassy Nautilus”, sold for the small fortune of 299 guilders at auction in Amsterdam. A Johannes Vermeer painting that originated from the same estate, “Woman in Blue Reading a Letter”, sold for roughly seven times less (Grout, 2011). The seashell is nowadays near-worthless; Vermeer’s oil paintings, in contrast, grace many of the world’s most important art collections, and are considered *price*less.

The example illustrates that high prices for collectibles are nothing new. Of course, already in the seventeenth century a run-up occurred in the prices of tulips, which were bought by wealthy collectors craving for something unique and exotic—and who therefore often collected seashells as well. The first business ventures designed to invest in collectibles probably date from the early twentieth century (Horowitz, 2011). In 1904, a French financier set up an art investment club called La Peau de l’Ours (“the skin of the bear”). The participants’ inlay was used to buy paintings, which were sold off at auction in 1914 (Watson, 1992). A century later, there are not only art funds, but also investment funds specializing in wine, violins, and many other luxury collectibles. The particularly strong interest in collectible goods as an investment in recent years can be explained by several factors. First, there is the long-term growth in the number of high-net worth individuals, who often spend a fraction of their wealth on “emotional assets” or “investments of passion”. Second, the financial crisis and economic uncertainty led many wealthy investors to approach their passion investments as investor-collectors, seeking out those items that are perceived to have tangible long-term value (Krawcheck and Lavayssière, 2010). Third, the increasing availability of historical data on collectibles facilitates a more thorough scrutiny of these alternative asset categories. These observations motivate our analysis of the long-run returns on three important collecting categories—stamps, art, and violins—in Sections 1 and 2 of this chapter.

It is clear, however, that investments in emotional assets come with unique risks, over and above "regular" price volatility. For example, sudden increases in supply led to a strong decline in seashell values in the nineteenth and twentieth century. Arguably more importantly for most buyers of collectibles today, however, is the issue of changes in tastes: collecting categories and artists can become more or less fashionable over time. Finally, there is the danger of forgeries and frauds. We discuss these issues more extensively in Section 3, prior to ending with some concluding thoughts in Section 4.

1. The long-term returns on collectibles

1.1. Stamps

Philatelic investment has recently become popular. The planned launch in 2010 of a regulated open-ended stamp investment fund, with monthly redemptions and subscriptions, is just one example (Bevins, 2010). A variety of pre-packaged portfolios and structured products provide economic exposure to investment-quality postage stamps (Hall, 2010).

We are the first to examine the long-term price trends of investment-quality stamps, based on all catalogues published by British stamp dealer Stanley Gibbons over the period 1900–2008. We start in January 1900 by identifying the 50 most valuable British stamps, whether unused or used. We then update our list of collectible stamps every nine years until end-1998. The focus is thus on very rare stamps, although we exclude special varieties, postage due stamps, control letters, and other non-regular stamp types. For each stamp identified, we track the prices from that point forward. We use the value-weighted arithmetic repeat-sales methodology developed by Shiller (1991), which starts from the purchase and sale date and price of each object to estimate the underlying portfolio returns. Full details of our data collection procedure and estimation methodology are provided in Dimson and Spaenjers (2011). To enable an analysis until end-2009, we chain-link our long-term annual index to the return on Stanley Gibbons' Great Britain 30 Rarities Index for 2009. The annualized (geometric mean) nominal return in GBP over the period 1900–2009 is equal to 7.0%. An inflation-corrected index is obtained by deflating the nominal index, using U.K. inflation data from Dimson, Marsh, and Staunton (2010). The annualized return on the real price index is 2.9%.

Figure 1 illustrates the annual nominal returns on stamps over the period 1900–2009. The strongest price increases occur in the second half of the 1960s, throughout the 1970s, and in the 2000s. Especially in 1976 (+77.7%) and 1979 (+83.2%), the returns are impressively high. Figure 1 shows that negative nominal returns are rare. However, the return distribution shows a clustering just above zero: we find nominal returns of 0% to 1% in about a quarter of all years. This suggests downward stickiness in nominal prices, but simultaneously implies that stamps can depreciate in real value over extended time periods.

[Insert Figure 1 about here]

Figure 1 also shows the rate of inflation per year, and the deflated stamp price index (against the right axis). Interestingly, in the inflationary second half of the 1970s, we do not only record the highest nominal, but also the highest real returns on stamps. At the time, many tangible assets became attractive as hedges, and therefore experienced relatively high returns (Ibbotson and Brinson, 1993). In recent years, too, collectible British stamps have appreciated substantially in value in both nominal and real terms. In 2008, the real stamp price index increased by more than 30%. The largest drops in deflated stamp prices can be observed over the First World War—when stamps lost half of their value in real terms—and in the early 1980s, but there are several other time intervals over which the real price level decreased. For example, between end-1948 and end-1957, we record nominal returns on stamps of 1% or lower, and inflation rates of 3% or higher, in every year.

1.2. Art

Since the first studies by Anderson (1974) and Stein (1977), an expanding literature has investigated the returns to art investments; examples include Baumol (1986), Pesando (1993), Goetzmann (1993), Mei and Moses (2002), Campbell (2008), Renneboog and Spaenjers (2010), and Goetzmann et al. (2011). To keep the focus on the long-term returns in the British market, we use data from Goetzmann et al. (2011) in this chapter. The authors collect high-end art auction transaction data for the U.K. from 1765 until 2007 from a much-used historical resource (Reitlinger, 1961) and an online sales database. Goetzmann et al. (2011) then utilize a Bayesian repeat sales methodology that incorporates a noise reduction technique to construct a deflated annual art price index. The Bayes formulation imposes some additional restrictions on the estimation, but leads to a more accurate estimator than the traditional repeat sales regression model when the number of observations is relatively small (Goetzmann, 1992). We chain-link the returns from Goetzmann et al. (2011) to two years of returns on the U.K. art market index of Artprice.com (2010) to get an index until end-2009. The annualized nominal return in GBP for the period 1900–2009 is equal to

6.5%, while the geometric average real return equals 2.5%. We show the deflated price index, together with the nominal returns and inflation rates, in Figure 2.

[Insert Figure 2 about here]

Figure 2 shows strong price appreciations throughout the 1960s, during the art market boom at the end of the 1980s, and in the mid-2000s. In contrast, prices dropped substantially (both in nominal and in real terms) during World War I, over the Great Depression, in the years after the 1973 oil crisis, during the early 1990s recession, and also in 2008. The negative shocks to wealth or top income levels during those periods clearly depressed high-end art prices.

1.3. Violins

A third collecting category for which long-run data exist—and in which specialized funds invest—are musical instruments. To construct a price index, we borrow data on repeated sales of violins, both at dealers and at auction houses, from Graddy and Margolis (2011). In their paper, the authors estimate returns for ten-year periods only, because of the small number of observations. In contrast, we construct a real annual price index by applying the Bayesian repeat sales regression presented before. Most purchases and sales were recorded in GBP, and therefore an index in that currency is constructed, in line with the previous two subsections. The deflated average price appreciation equals 2.9%, which is very similar to the long-run performance of stamps and art. The results can be found in Figure 3.

[Insert Figure 3 about here]

Figure 3 shows strong increases in the price level of violins over the 1920s and after 1960, with temporary declines in the mid-1970s, the early 1990s, and the early 2000s. Returns were generally negative for longer periods during the First World War and between 1930 and the late 1950s.

1.4. Other collectibles

For most other collectibles, information on their long-run price evolutions is less widespread; research on collectibles has mainly focused on returns over shorter time frames—see, for example, Burton and Jacobsen (1999). However, some data points still deserve mentioning. For wine, the historical auction data from Christie's London described in Jovanovic (2007) indicate that the price of a case of 1870 Château Lafite-Rothschild was around 3 GBP in 1900, but could cost more than

60,000 GBP at the end of the twentieth century. Data from the second and the 95th volume of Book Auction Records show that a first edition of Charles Darwin's "Origin of the Species" sold for 2 GBP in 1905, but for 11,000 GBP in 1997. Both cases would suggest average yearly nominal returns of around 10%—a performance close to that of equities (cf. infra). However, since it is unclear to which degree these examples are representative for the price trends of a broad portfolio of exclusive wines or rare books, we limit our attention in the next sections to the detailed stamp, art, and violin return series presented earlier.

2. Comparison with financial assets

Now that we have established a 110-year history of the returns on stamps, art, and violins, we can compare these returns with those on U.K. Treasury bills, government bonds, and equities. The return data for these financial asset classes are from Dimson, Marsh, and Staunton (2010). We also look at gold, using prices from Global Financial Data and Datastream. The real price evolutions since year-end 1899 are shown in Figure 4.

[Insert Figure 4 about here]

Intriguingly, the geometric average returns are virtually identical for the considered collectibles over the 1900–2009 period. Yet, despite the similarity in long-term returns, short-term trends can vary substantially across the different types of collectibles. For example, violins outperformed art and stamps in the inter-war period, while stamps did best in the inflationary 1970s. The (untabulated) real return correlations are therefore not very large; they range from 0.07 (between stamps and violins) to 0.24 (between art and violins).

Figure 4 also shows that equities have outperformed all other asset categories, including stamps, art, and violins, over the period 1900–2009. Equities have realized a yearly average real return of 5.3%, while our collectibles have appreciated by between 2.5% and 2.9% per year in real terms. However, over the very long term, collectibles have enjoyed higher returns than bonds or bills, which record average real returns of less than 1.5%. Gold realized an average real return of only 0.8%. A full overview of the distribution of the nominal and real returns on the assets included in this study can be found in Table 1.

[Insert Table 1 about here]

Of course, there are also important differences in transaction costs between assets; buyer's premia, seller's commissions, and dealer mark-ups on collectibles can be high. For stamps, Dimson and Spaenjers (2011) demonstrate that a 25% transaction cost at sale has historically only been covered by the appreciation in nominal value after four years or more. Given the similarities in average returns and transaction costs, the same probably applies to many other collectibles.

3. Investment risks

3.1. Return volatility

We could evaluate the historical riskiness of investments in collectibles by considering standard deviations. Table 1 shows standard deviations of the nominal returns on stamps, art, and violins of 13.6%, 13.3%, and 9.7%, respectively, while we record standard deviations of 11.8% for bonds and 21.7% for equities. A problem with the raw standard deviations of the stamp, art, and violin returns is that they underestimate the true volatility of collectibles values, for a number of reasons. First, appraisals of an infrequently traded item's value, such as stamp catalogue prices, are typically sticky (Geltner, 1991). Second, the Bayesian repeat sales regression, used to estimate the returns on art and violins, may induce positive autocorrelation (Goetzmann, 1992). Third, insofar as the indices are averages of time-ordered values, the variance of the returns can be expected to be underestimated by as much as one third (Working, 1960; Breeden et al., 1989).

A remedy is to unsmooth the returns, by removing the first-order autocorrelation from the real return series, as described in Dimson and Spaenjers (2011), or by correcting for the methodology-induced autocorrelation. Although the revised return series will have an average that lies very close to the one of the original series, the standard deviation will be substantially higher. For example, Dimson and Spaenjers (2011) report that the riskiness of stamp investments, as measured by the volatility of the unsmoothed returns, is not much different from that of investments in equity markets. Renneboog and Spaenjers (2010) come to a similar conclusion for the art market.

3.2. Changes in tastes

Keeping supply constant—which is not always an innocuous assumption, as illustrated by the history of seashells—returns on collectibles ultimately depend on (future) demand. This may be hard to predict, since tastes change over time. Johannes Vermeer, for example, was completely "absent in art lexica prior to his 'discovery' in the nineteenth century" (De Laet et al., 2011). As late as 1881, the painting "Girl with a Pearl Earring", albeit in poor condition, sold for not more than two guilders in Amsterdam. A shift in fashion made Vermeer a very popular artist in the late twentieth century—and his works more valuable than the majority of the five million other paintings produced in the Netherlands in the seventeenth century (Conniff, 2009). Of course, over time, whole collecting categories can become more or less fashionable. Reitlinger (1963) documents the astonishingly high prices paid for silverware—some of it "inconceivably hideous"—at the end of nineteenth century, and for tapestry in the early twentieth century. At the time, prices paid for the highest-quality "objets d'art" were many times those laid out for the most expensive art works. Art only gradually became a more valuable collecting category, eventually commanding the exorbitant prices observed in recent decades.

Not only aesthetic tastes, but also wealth distributions may change, with important consequences for collectibles prices. The Japanese boom in the late 1980s caused a bubble in those kinds of art favored by Japanese collectors (Hiraki et al., 2009); something similar is happening today with Chinese and Russian art. Renneboog and Spaenjers (2011) put it as follows: "changing wealth patterns and the corresponding changes in demand based on the cultural and regional affinities of these new collectors may have a significant impact on changes in relative art valuation".

A somewhat related point is that also investing preferences may fluctuate. Like gold (and diamonds), stamps outperformed many other asset classes in the late 1970s—and therefore hedged against inflation ex post—because many investors *perceived* stamps to be an excellent hedge against inflation ex ante. This does not imply that stamps and other collectibles will always be a good hedge in the future.

The previous paragraphs point to the danger of survivorship bias in every research on collectibles. We may mainly be estimating returns on the artists and collectibles that have not fallen out of fashion with wealthy western collector-investors in recent times, upwardly biasing results (Goetzmann, 1996). Today, one must wonder whether all collectibles that have been important over the last century will hold their appeal in the future. For example, it is telling that between 1982 and 2007 the average age of the members of the American Philatelic Society rose from 44 to 63 (American Philatelic Society, 2007). Moreover, although the inflow of new collectors from emerging economies can somewhat compensate for the lower interest in stamps among younger generations in developed economies, their focus may be on own-country stamps and on different types of issues (Huang, 2001).

It seems fair to say, however, that the risks described above are mainly important to those investor-collectors who have a long time horizon. Renneboog and Spaenjers (2010) examine persistence in tastes in the art market over the last half century. They find that Vincent Van Gogh was the most valuable artist in the 1960s, 1980s, 1990s, and 2000s. Four artists feature in the top-ten of each of the five considered decades: Van Gogh, Monet, Degas, and Cezanne. More generally, the correlations between individual artist price levels across periods are high. The authors therefore conclude that "stylistic risk may mainly be an issue over the very long term".

3.3. Forgeries and frauds

The most visible risk of investing in collectibles is probably that of forgeries and frauds, which have long been a danger in philately (Lake, 1970). For example, in 1961, one particular stamp type was deleted from the Stanley Gibbons catalogue "as all copies [were] believed to be manipulated" (Stanley Gibbons, 1960). More recently, there have been examples of fraudulent stamp systems (Crawford, 2005, 2006).

Lately, there have also been concerns about counterfeit wines. The Economist (2011) reported that "by some estimates 5% of fine wines sold at auction or on the secondary market are not what they claim to be on the label". Wine bottles can be relabeled, or refilled with cheaper wine. One of the reasons that wine fraud is so widespread is that "many buyers wait years before opening their fraudulent bottles, if they open them at all" (Koch, 2007). Even if, after opening, the wine does not taste right, collectors may not have the experience to realize that they have been duped. In other cases, collectors may not admit that they have been defrauded, because they do not want to damage the vintage's reputation (The Economist, 2011).

4. Conclusion

Less than a decade ago, Stanley Gibbons' view on stamp investment emphasized the hobbyist. Levene (2002) reported that "In the U.K., the best advice from the stamp world is to give up all thoughts of philately as an investment. Mention that '*i*' word in Stanley Gibbons in London's Strand, and the staff at the world's biggest stamp dealers go into palpable shock." Today, the emphasis is more on the collector-investor, and not only at Stanley Gibbons. Collectibles are nowadays considered as an asset category that have the potential to contribute to a diversified investment portfolio.

In this chapter, we have reviewed the long-term investment performance of three important categories of emotional assets—stamps, art, and violins—and drawn comparison with the returns from investing in financial assets. Even though they do not generate any financial income, the long-run returns on collectibles are superior to the total return from government bonds and Treasury bills (and gold).

However, the investment risk of emotional assets is larger than is suggested by simple standard deviations, and further augmented by their exposure to fluctuating tastes and vulnerability to frauds. When choosing an investment horizon, one needs to trade off between high transaction costs and the risk of short-term, cyclical underperformance on the one hand, and the risk of longer-run shifts in the tastes of the dominant collectors and investors in the market on the other. Finally, the heterogeneity of collectibles—largely unaddressed here—may make asset selection challenging, since it is not possible to simply invest in the stamp, art, or violin price indices presented in this chapter. Renneboog and Spaenjers (2010) provide evidence of variation in performance across art mediums, movements, and quality categories. Cross-sectional differences in the sensitivity to changes in demand may be partially responsible, but more research on return determinants is clearly needed.

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Table 1—Distributions of returns and correlation coefficients

Table 1 reports the geometric and arithmetic average return per annum (p.a.), the standard deviation (S.D.), and the lowest and highest recorded return for different emotional and financial asset classes over the time frame 1900–2009. The return data for stamps come from Dimson and Spaenjers (2011) and Stanley Gibbons. The returns data for art come from Goetzmann et al. (2011) and Artprice.com (2010). The returns for violins are estimated based on transaction data from Graddy and Margolis (2011). The return data for equities, bonds, bills, and inflation come from Dimson, Marsh, and Staunton (2010). Gold prices are downloaded from Global Financial Data and Datastream.

	Mean returns p.a.		Dispersion of annual returns				
	Geometric	Arithmetic	S.D.	Lowest		Highest	
Nominal returns							
Stamps	7.0%	7.7%	13.6%	-8.8%	1982	83.2%	1979
Art	6.5%	7.4%	13.3%	-31.1%	1930	46.6%	1968
Violins	6.9%	7.4%	9.7%	-13.0%	2002	23.9%	1986
Equities	9.4%	11.3%	21.7%	-48.8%	1974	145.6%	1975
Bonds	5.3%	5.9%	11.8%	-17.4%	1974	53.1%	1982
Bills	5.0%	5.1%	3.7%	0.5%	1946	17.2%	1980
Gold	4.7%	6.1%	19.6%	-23.9%	1997	131.1%	1979
Inflation	4.0%	4.2%	6.6%	-26.0%	1921	24.9%	1975
Real returns							
Stamps	2.9%	3.6%	12.4%	-19.2%	1915	56.3%	1979
Art	2.5%	3.3%	12.4%	-29.7%	1915	38.4%	1968
Violins	2.9%	3.2%	8.0%	-14.7%	1938	40.9%	1974
Equities	5.3%	7.2%	20.0%	-57.1%	1974	96.7%	1975
Bonds	1.4%	2.2%	13.6%	-30.7%	1974	59.0%	1921
Bills	1.0%	1.2%	6.3%	-15.4%	1915	42.4%	1921
Gold	0.8%	2.0%	17.3%	-30.5%	1975	97.1%	1979

Figure 1—Nominal returns and deflated price index of stamps

Figure 1 shows the nominal GBP returns on art over the time frame 1900–2009, based on Dimson and Spaenjers (2011) and Stanley Gibbons. It also presents U.K. inflation in each year, and the deflated stamp price index. The index is set equal to 100 at the beginning of 1900. Inflation data come from Dimson, Marsh, and Staunton (2010).

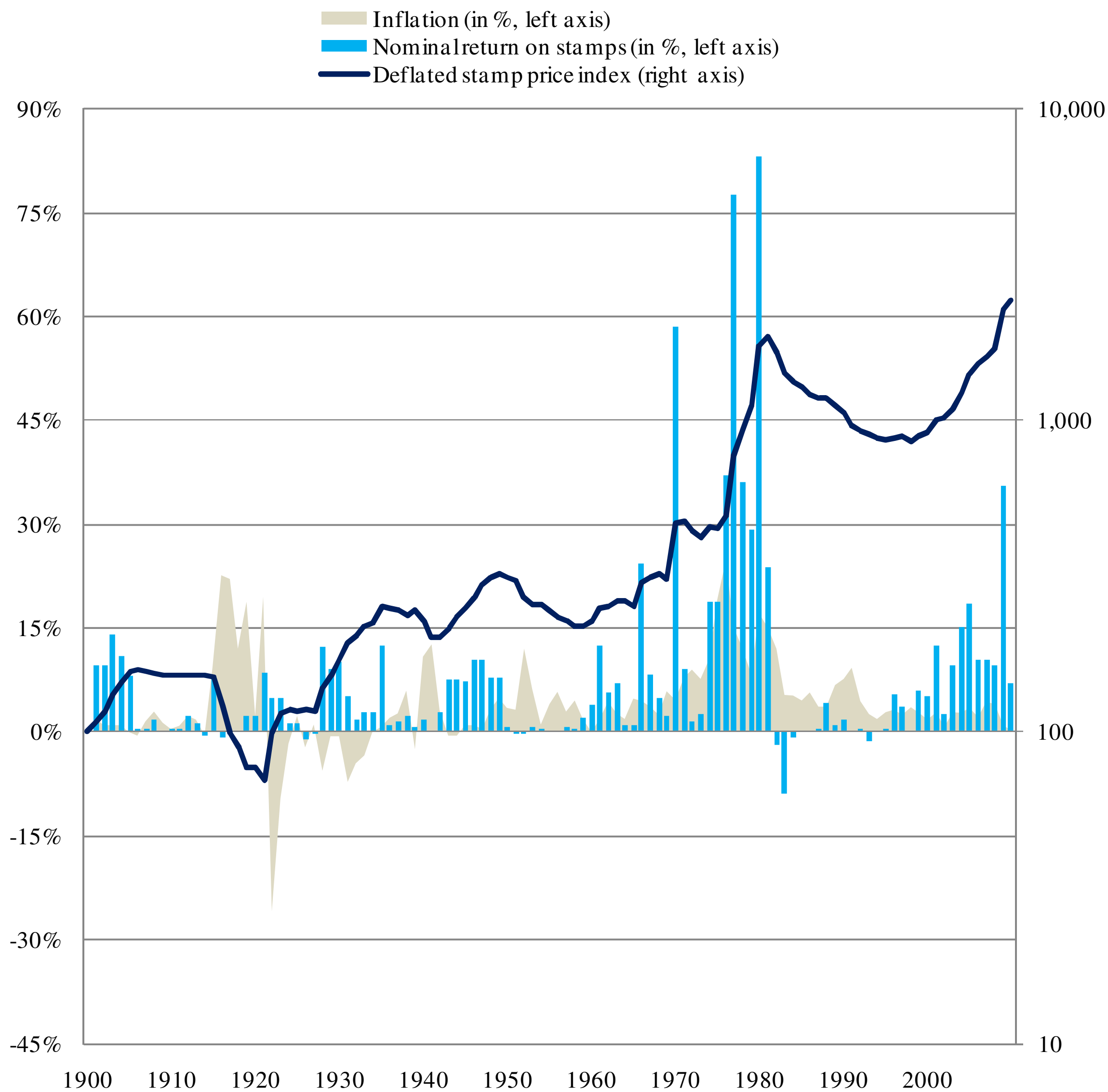


Figure 2—Nominal returns and deflated price index of art

Figure 2 shows the nominal GBP returns on art over the time frame 1900–2009, based on Goetzmann et al. (2011) and Artprice.com (2010). It also presents U.K. inflation in each year, and the deflated art price index. The index is set equal to 100 at the beginning of 1900. Inflation data come from Dimson, Marsh, and Staunton (2010).

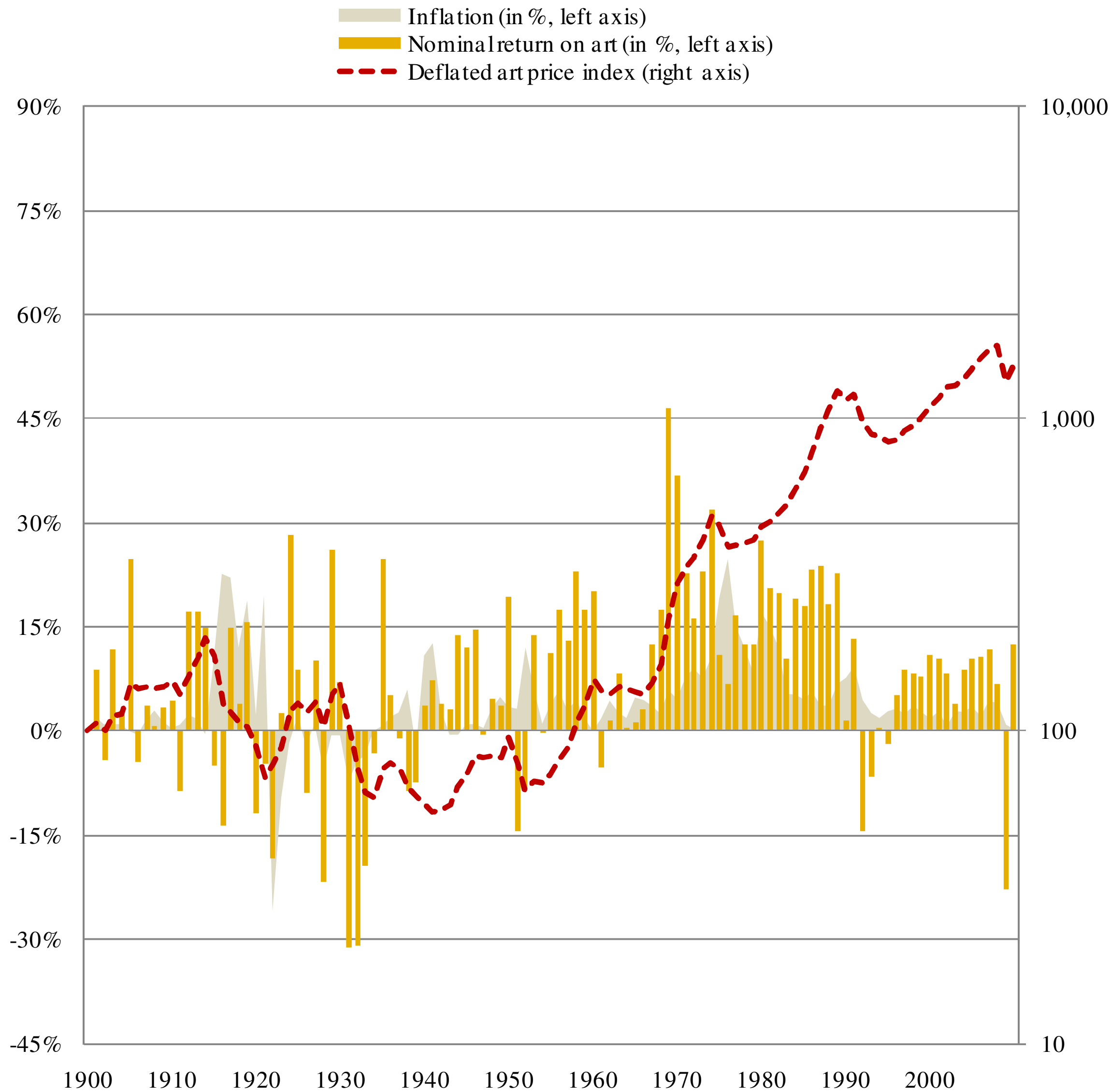


Figure 3—Nominal returns and deflated price index of violins

Figure 3 shows the nominal GBP returns on art over the time frame 1900–2009, based on transaction data from Graddy and Margolis (2011). It also presents U.K. inflation in each year, and the deflated violin price index. The index is set equal to 100 at the beginning of 1900. Inflation data come from Dimson, Marsh, and Staunton (2010).

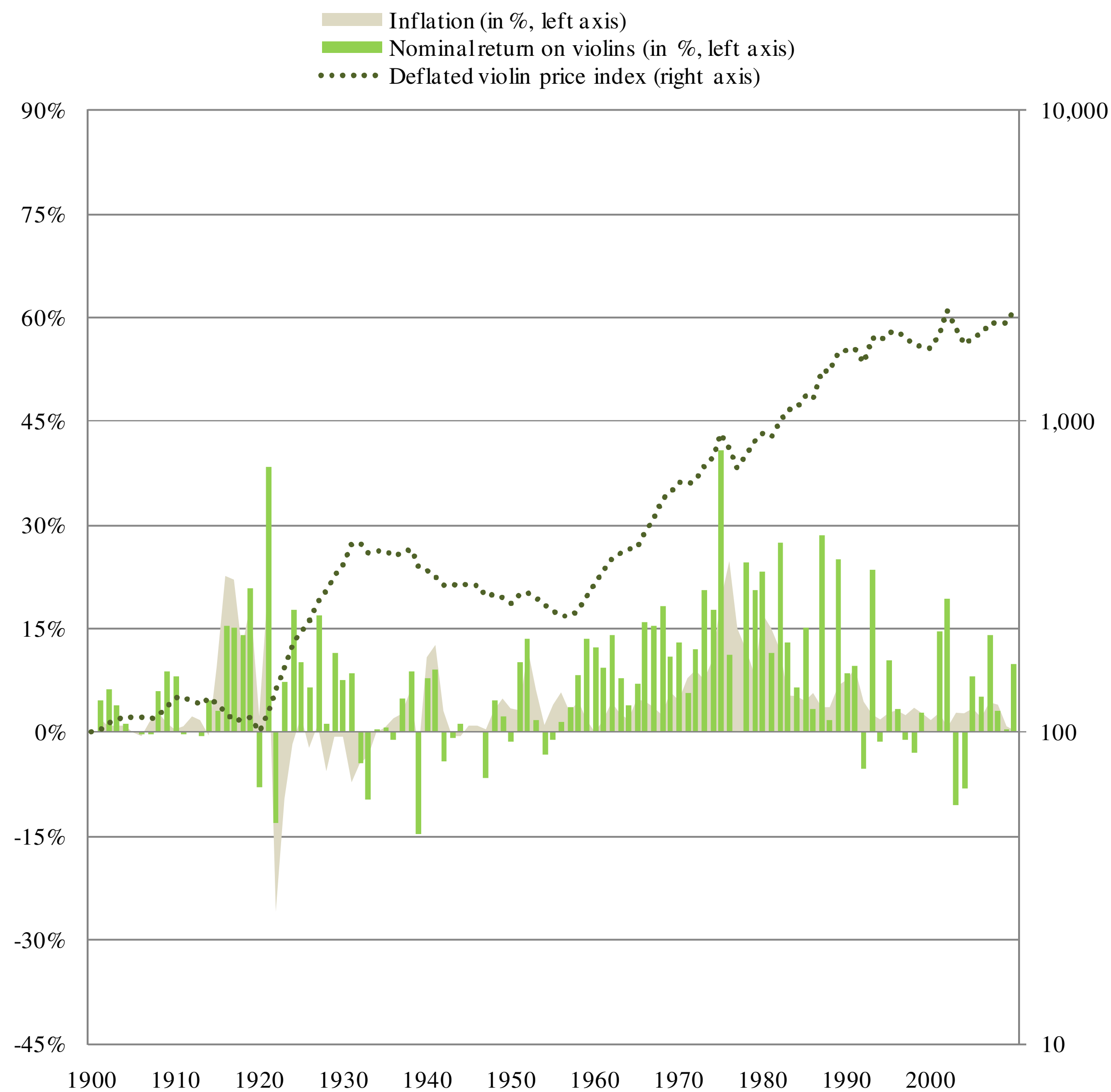
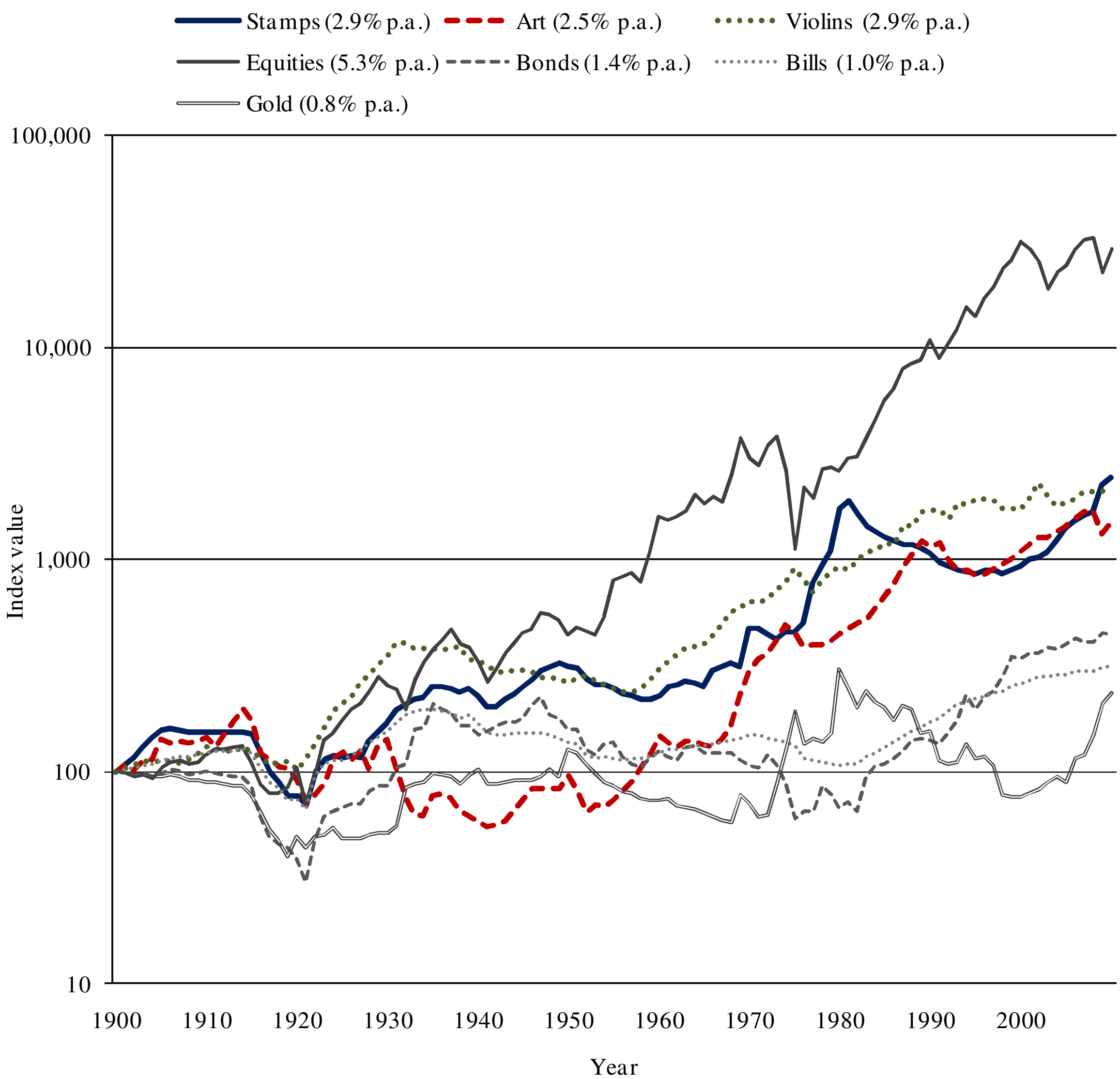


Figure 4—Comparison of returns

Figure 4 shows the deflated index values for stamps, art, violins, equities, bonds, bills, and gold over the time frame 1900–2009. It also presents the geometric average real return per annum (p.a.) for each asset category. Each index is set equal to 100 at the beginning of 1900. The real price index data for stamps, art, and violins are shown in Figures 1–3. The return data for equities, bonds, and bills come from Dimson, Marsh, and Staunton (2010). Gold prices are downloaded from Global Financial Data and Datastream.



Chapter 2

Buying beauty: On prices and returns in the art market

Abstract: This paper investigates the long-term investment performance of art. We apply a hedonic regression analysis to a new data set that contains more than one million auction transactions of paintings and works on paper. Based on the resulting price index, we conclude that art has appreciated in value by a moderate 4.04% per year, in real U.S. dollar terms, between 1957 and 2007. Over our time frame, art has outperformed other tangible assets and government bonds, but underperformed stocks. Despite substantial transaction costs, it may be optimal for long-horizon investors to allocate a small fraction of their portfolio to masterpieces, which yield higher returns than lower-quality works of art.

Stories about the baffling amounts of money paid for first-tier art periodically entertain newspaper readers around the world. The recent growth in the number of multi-million dollar sales—the online database Art Sales Index recorded more than a thousand hammer prices above one million U.S. dollars (USD) in 2007 and in 2008—has also caused increased attention to art as an investment. In turn, the belief in art as a viable alternative asset class has led to the creation of several art funds (e.g., The Fine Art Fund) and art market advisory services, which cater to affluent individuals who consider investing in art.

There is a growing academic literature on art investments, but researchers have studied relatively small data sets and have failed to consider the role of some important price-determining characteristics (e.g., reputation and attribution). This paper tries to shed more light on the price formation and returns in the art market by addressing these concerns. We first compile a comprehensive list of more than 10,000 artists, and then collect information on more than one million auction sales of paintings and works on paper by these artists. Our data enable us to perform an extensive hedonic regression analysis and construct solid price indices, both for the art market as a whole and for a number of submarkets.

Our results show that the reputation of the artist, the strength of the attribution, and the topic of the work have a significant impact on the price of an art object. In addition, we confirm the importance of more traditional hedonic characteristics, such as size, medium, and the timing and location of the sale. On average, art prices have increased by a moderate 4.04% in real USD terms on a yearly basis between 1957 and 2007. Over the last quarter of a century the average annual real return was 4.55%. Returns can be substantially higher during boom periods, such as 1985–1990 and 2002–2007. The investment performance also varies across mediums and movements: oil paintings and post-war art movements have appreciated faster than other collecting categories.

The results are robust to a large number of alternative specifications. Allowing for changing tastes does not materially affect our results. Using non-price measures of quality, we find evidence on the existence of a positive masterpiece effect: better art makes a better investment. This result is in line with models on the economics of superstars, and is corroborated by the observation that quality has commanded an increasing premium over time.

After desmoothing our art index, we find that art investments have yielded lower returns and higher risks than stocks since 1957 (and than corporate bonds over the last quarter of a century). However, art has outperformed other physical assets (gold, commodities, and real estate) and government bonds. In art buyers' portfolios, art may crowd out commodities first and corporate bonds afterwards. Although the high transaction costs associated with trading art further reduce the observed returns, high-quality art may have its place in the optimal portfolio of a long-horizon investor.

The remainder of this paper is structured as follows. Section 1 briefly reviews the literature on art indices and returns. Section 2 describes our data set. Section 3 outlines our baseline results, which are tested for robustness and extended in Section 4. Section 5 compares our returns to those on a number of other investments and incorporates a portfolio analysis. Section 6 concludes.

1. Literature on art returns

Researchers have used different methodologies to calculate the financial returns on art investments, starting from public auction records. Stein (1977) considers the auctioned objects in each year as a random sample of the underlying stock of art (by deceased artists), and constructs an index based on the *yearly average transaction price*. Baumol (1986) and Frey and Pommerehne (1989) calculate the *geometric mean return* on works that sold at least twice during the considered time frame.

However, these simple methods do not enable the construction of a price index that adjusts for variations in quality. Therefore, most recent studies have used either repeat-sales regressions or hedonic regressions to measure the price movements of art (or other infrequently traded assets, such as real estate).

Repeat-sales regressions explicitly control for differences in quality between works by only considering items that have been sold at least twice. The repeat-sales regression estimates the average return of a portfolio of assets in each time period, based on purchase and sale price pairs. Pesando (1993), Goetzmann (1993), Mei and Moses (2002), and Pesando and Shum (2008), among others, have applied the methodology to art investments. There are three disadvantages to the use of the repeat-sales methodology. First, it may be practically difficult to identify repeated sales of identical items. Second, since art objects trade very infrequently, only considering repeated sales decimates any data set to a small number of observations (typically less than 10,000, unless the focus is on multiples of prints). Third, a repeat-sales sample may not be representative for the overall population of art works, especially when only resales at top auction houses are taken into account.

Hedonic regressions control for quality changes in the transacted goods by attributing implicit prices to their “utility-bearing characteristics” (Rosen, 1974). Prices are regressed on these hedonic characteristics and time dummies. The coefficients on the latter variables can then be used to build a price index. One of the key difficulties is the choice of hedonic characteristics (Ashenfelter and Graddy, 2003). Observable and easily quantifiable features such as size, medium, and the location of sale are frequently used (Anderson, 1974; Buelens and Ginsburgh, 1993; Chanel et al., 1996; Agnello and Pierce, 1996), but the number of hedonic variables often stays relatively limited. The literature has failed to systematically include variables that measure reputation or the strength of attribution, an important price-determining factor for Old Masters (Robinson, 2005). Also, just like in repeat-sales studies, the utilized samples have been relatively small. The research has been based either on books that include data up to the 1960s only (Buelens and Ginsburgh, 1993; Chanel et al., 1996), or on selective samples of art from one country (Agnello and Pierce, 1996; Renneboog and Van Houtte, 2002; Higgs and Worthington, 2005).

The estimated returns on art vary widely with data, methodology, and the time period under consideration. With respect to paintings, the two most influential repeat-sales studies report relatively high real returns over the twentieth century. Goetzmann (1993) calculates an average annual real appreciation of 13.3% between 1900 and 1986, while Mei and Moses (2002) reports a real return of 8.2% between 1950 and 1999. In general, studies that use the hedonic pricing methodology have found lower returns, but to date no exhaustive hedonic analysis has been undertaken.

2. Data and methodology

We run a hedonic regression to construct a price index for art. An advantage of this approach is that information on all observable transactions can be taken into account. Our model relates the natural logs of real USD prices to year dummies, while controlling for a wide range of hedonic characteristics:

$$\ln P_{kt} = \alpha + \sum_{m=1}^{M} \beta_m X_{mkt} + \sum_{t=1}^{T} \gamma_t D_{kt} + \varepsilon_{kt} \ , \qquad (1)$$

where P_{kt} represents the price of good k at time t, X_{mkt} is the value of characteristic m of object k at time t, and D_{kt} is a time dummy variable that takes the value one if good k is sold in period t (and zero otherwise). The coefficients β_m reflect the attribution of a shadow price to each of the m characteristics, while the antilogs of the coefficients γ_t are used to construct a hedonic index. Triplett (2004) notes that these antilogs are not entirely unbiased estimates of the time effects, but that the bias in the resulting returns is very small.

We describe our data in subsection 2.1. The hedonic variables that will be used in the estimation of Equation (1) are presented in subsection 2.2.

2.1. Data

We focus on the market for oil paintings and works on paper (i.e., watercolors and drawings), which accounts for a substantial proportion of all transactions in the art market. We start by compiling a list of artists. This selection of artists has to be as exhaustive as possible, so as not to have a bias towards artists that are popular (right now), and therefore we consult several authoritative art history resources. Our artist selection procedure, of which details can be found in Appendix A, culminates in a list of 10,442 artists. We classify 4,490 of those artists in one or more of the following art movements: Medieval & Renaissance; Baroque; Rococo; Neoclassicism; Romanticism; Realism; Impressionism & Symbolism; Fauvism & Expressionism; Cubism, Futurism & Constructivism; Dada & Surrealism; Abstract Expressionism; Pop; and Minimalism & Contemporary.

We then collect data on all relevant sales by manually matching our list of names with all artists in the online database Art Sales Index [http://www.artinfo.com/artsalesindex].[1] This resource contains auction records for different types of art. Prices are hammer prices, exclusive of transaction costs.[2] Although the first sales in the Art Sales Index date from the beginning of the 1920s, data are unavailable or sparse in many years until the second half of the 1950s. Therefore, we start our analysis in 1957, the first year for which we have more than 1,000 observations. The most recent auction records available for this study are from the autumn auctions of 2007. The Art Sales Index only includes London sales until the late 1960s, but it has excellent worldwide coverage, even of local auction houses, afterwards.

Our final data set consists of 1,088,709 sales; about 60% of these transactions concern oil paintings, with the remainder split roughly evenly between watercolors and drawings. The sample includes more than 10,000 auctioned objects per year for all years since 1973. The artist with the highest numbers of sales (5,405) is Pablo Picasso. The magnitude of our database enables us to draw a complete picture of the price formation and the returns in the art market, in contrast to most previous studies which are based on more selective samples. We translate all nominal prices in our data set to prices in year 2007 USD, using the CPI as a measure of inflation. In real terms, the most expensive transaction in our data set is 'Portrait du Dr. Gachet' by Vincent van Gogh, which sold for 75 million USD in May 1990.

Goetzmann (1996) argues that sales by artists who "fall from fashion" are not considered in databases based on auction transactions. Hence, survivorship could cause an upward bias in the estimated returns. Thanks to the large number of artists and auction houses included, especially in the second half of our time frame, this bias should not impact strongly on our results. Indeed, if an artist's work that initially sold at a big auction house becomes less fashionable and subsequently sells at a smaller auction house, it will still be included in our sample. Of course, in the exceptional case that art falls out of fashion completely, it will not be included in any auction, and returns may

[1] We check for pseudonyms and different spellings of the artist's name when relevant. As a validation of our data collection process, we also check that our database does not contain double entries.

[2] Historically, the Art Sales Index has not included buy-ins. Since reserve prices in the art market tend to follow recent sales prices, this can lead to a return measurement bias when the market reverses (Goetzmann and Peng, 2006). However, over longer time periods this should not make an economically significant difference.

be biased upwards. However, inexpensive works from before an artist's breakthrough may not have appeared at auction either, imparting a downward bias on returns (Mei and Moses, 2002). Also pieces that are donated to museums after substantially increasing in value are not included in auction databases (Goetzmann, 1993; Mei and Moses, 2002). We assume that these different biases are relatively small in absolute terms and approximately offset each other, and therefore do not materially affect our results.

2.2. Variables

In addition to year dummies, our hedonic regressions include a number of variables that capture the characteristics of the artist, of the work, and of the sale. The descriptive statistics for these hedonic variables are presented in Table 1.

[Insert Table 1 about here]

First, in addition to the artist dummies capturing each artist's uniqueness, we consider the following reputational measure:

> *Textbook dummy*. As an exogenous proxy for recognition, we check which of our artists were included in several editions of the classic art history textbook 'Gardner's Art Through the Ages' (1926, 1959, 1980, 1996, and 2004). In total, 652 of our artists are listed in at least one edition. The dummy variable TEXTBOOK equals one if the artist was featured in the edition of—or the last edition prior to—the year of sale.

Two other characteristics related to the artist's career are included in the late-twentieth-century movement-specific models, but not in our general models, as they could potentially pick up price differences between various eras or movements:

> *Exhibition dummy*. The variable EXHIBITION equals one once the artist has been represented at Documenta in Kassel. We argue that inclusion in this prestigious exhibition has a certification effect, and evidences an artist's rise to fame. In total, 680 of our artists were represented at one of the eleven exhibitions between 1955 and 2002.
>
> *Dead artist dummy*. It is often assumed that prices for art works increase after the death of an artist. The dummy variable DECEASED, which equals one if the sale occurs subsequent to the artist's death, should capture this effect. The large majority of transactions (almost 90%) concerns art by deceased artists.

Second, we also consider a range of price-determining variables that capture the attribution and authenticity, the medium, the size and the subject matter of the work of art:

Attribution dummies. Attribution can be an important factor influencing the price of art objects, especially of older works. There are different levels of attribution that are used in the auction world, reflecting different levels of certainty: ATTRIBUTED (to), STUDIO (of), CIRCLE (of), SCHOOL (of), AFTER, and (in the) STYLE (of). About 12% of the observations in our sample carry such an attribution.

Authenticity dummies. More than half of the art works is SIGNED, while about one third is DATED. We want to check whether a signature or a date imparts a premium.

Medium dummies. We introduce dummies for the different medium categories: OIL, WATERCOLOR (including gouaches), and DRAWING.

Size. The height and width in inches are represented by HEIGHT and WIDTH, with the squared values being HEIGHT_2 and WIDTH_2. The average work has both a height and a width of slightly more than 20 inches (51 cm).

Topic dummies. Psychological (e.g., Feist and Brady, 2004) and neuroscientific (e.g., Ramachandran and Hirstein, 1999) studies have presented evidence that the subject matter can significantly affect the aesthetic appreciation of art objects. We therefore categorize the works in different topic groups based on the first word(s) of the title. We create the following eleven categories, based on the search strings that can be found in Appendix B: ABSTRACT, ANIMALS, LANDSCAPE, NUDE, PEOPLE, PORTRAIT, RELIGION, SELF-PORTRAIT, STILL_LIFE, UNTITLED, and URBAN. Furthermore, we create a dummy STUDY that equals one if the title contains the words “study” or “etude”. The largest categories are portraits and landscapes.

Third, we include dummies that indicate the timing of the sale and the reputation and location of the auction house:

Month dummies. Since important sales are often clustered in time, we include month dummies. The busiest months are May, June, November, and December.

Auction house dummies. We make a distinction between different fine art auction houses that have been important throughout our sample period. For Sotheby’s and Christie’s, we introduce dummy variables for their London, New York, and other sales (e.g., SOTH_LONDON, SOTH_NY, and SOTH_OTHER). Together, these two institutions are responsible for about half of all sales in our sample. For two other big British auction houses, Bonhams and Phillips, we make a distinction between their London sales rooms and other activities (e.g., BON_LONDON and BON_OTHER). We also create two dummies to account for the sales by important European and American auction houses (AUCTION_EUROPEAN and AUCTION_AMERICAN). Appendix C lists the auction houses included in the last two categories.

3. Empirical results

In this section, we outline the results of different hedonic regression models on the pooled data. In all cases, the model is estimated using ordinary least squares and the dependent variable is the natural log of the real price in USD. We start with a general all-art model. Subsequent regressions repeat the model for different mediums and movements.

Table 2 shows the parameter estimates of the hedonic variables for our baseline model. For 1,078,482 sales we have complete information on all hedonic characteristics presented in the previous section. Thanks to the very large number of observations, nearly all coefficients are statistically highly significant, and hence we want to focus on economic significance as well. Table 2 therefore also includes the "price impact" of each hedonic variable, which can be calculated by taking the exponent of the coefficient, and substracting one. However, it is important to note that in most cases the regression coefficients reflect correlation instead of causality. For example, works sold at Sotheby's or Christie's mainly catch higher prices because of high quality, not because of auction house certification.

[Insert Table 2 about here]

Table 2 reveals that works are on average priced 13.5% higher after the inclusion of the artist in an important textbook. Also the strength of the attribution has an important effect on the price of an art object. Whenever an attribution dummy comes into play, the price level drops by more than 50%. Not surprisingly, the largest discounts are recorded for works that are "in the style of" or "after" a master. We also observe that signed and dated works carry higher prices: a signature increases the price by as much as 31% on average, while a date adds almost 19% in value. Works on paper are priced lower than oil paintings, and drawings are less valuable than watercolors. Furthermore, prices increase with size, up to the point that the work becomes too large, as indicated by the negative coefficients on the squared terms. Regarding the topic dummies, there are significant discounts associated with studies and portraits, while self-portraits trade at a premium. The coefficients on our time-of-the-year dummies confirm that the most expensive auctions are clustered at the ends of the spring and the autumn. Finally, the highest prices are paid at the main offices of Sotheby's and Christie's.

From the artist dummy coefficients (not reported) we can infer who have been, over the last half century, the most expensive artists at auctions, controlling for all hedonic characteristics. Since we want to focus on artists that trade regularly and sell for high prices consistently, we only consider artists with at least 100 sales in our data set. The top-ten, in decreasing order, goes as follows: Vincent van Gogh, Jasper Johns, Claude Monet, Paul Cezanne, Georges Seurat, Francis Bacon, Alfred Sisley, Edgar Degas, Vasily Kandinsky, and Edouard Manet.

Based on the coefficients on the time dummies (not reported), we construct an art price index. Panel A of Figure 1 depicts the evolution of this index over our time frame; the price level in 1957 is standardized to 100. Using the index, we calculate that, on average, art has appreciated at a yearly real rate of 4.04% on average between 1957 and 2007. Over the last 25 years, the geometric mean real return is slightly higher (4.55%). The nominal equivalents, obtained by correcting the indices for the year-to-year changes in the CPI series, are 8.29% (1957–2007) and 7.80% (1982–2007). In boom periods, prices can increase very fast: they more than tripled in real terms between 1982 and 1990. The average yearly increase in prices between 1985 and 1990 exceeded 22%.[3] However, prices also rapidly decreased after 1990, and no large changes in price levels occurred between the mid-1990s and the first years of the 2000s. In the most recent art boom period (2002–2007), the real price appreciation averaged 11.65%.

[Insert Figure 1 about here]

We now repeat the hedonic regression analysis on three complementary subsamples of our data set: oil paintings, watercolors, and drawings. The coefficients on the hedonic variables (not reported) are very much in line with the previous results. Panel A of Figure 1 also shows the evolution of the price indices for the three mediums since 1957. Although the trends are similar across the different types of art, we see faster price increases for oil paintings than for the other two categories. In real terms, watercolors and drawings were on average still priced lower in 2007 than in 1989 and 1990. Table 3 reports the returns over different time frames, and compares them to the returns on the all-

[3] Hiraki et al. (2009) describe how strong Japanese demand pushed up prices in the art market in the late 1980s.

art index. Over the last half century, prices for oil paintings have appreciated at a yearly average real rate of 4.58%, while watercolors and drawings have increased by 3.44% and 2.40% annually.

[Insert Table 3 about here]

Finally, we run a separate hedonic regression for each movement, based on the classification of each artist. We add the variables EXHIBITION and DECEASED to the models for the three most recent art movements (Abstract Expressionism, Pop, and Minimalism & Contemporary). Most artists of these movements have been active over our time frame, which will enable a correct measurement of exhibition and death effects. We find that EXHIBITION is significantly positive in the Abstract Expressionism and Minimalism & Contemporary set-ups; in the latter model we also observe a clearly positive death effect (not reported). We do not go into detail on the results for the other hedonic characteristics.[4] The average yearly real returns for the different art movements since 1957 and since 1982 are reported in Table 3. Since 1957, the indices have increased by between 2.70% and 5.68% on average per year. Between 1982 and 2007 only the post-war art movements Abstract Expressionism, Pop, and Minimalism & Contemporary have shown real price appreciations of more than 6% per annum, on average. However, the standard deviations show that these movements have also been the more volatile (and thus riskier) ones. Romanticism, Realism, and Fauvism & Expressionism record mean appreciations of less than 4% over the same time frame. All art paradigms move with the same trends, but it is remarkable how much post-war art has outperformed earlier movements when the art market is booming. For example, between 1985 and 1990 and between 2002 and 2007, the price index of Pop art increased at yearly rates of 40.59% and 21.82%, respectively. The indices for three art movements from different time periods (Rococo; Cubism, Futurism & Constructivism; and Pop) are plotted in Panel B of Figure 1 from 1982 onwards. The figure reveals that a post-war art movement like Pop is extremely profitable when the art market is doing well, but also falls much more in value when the boom is over.

[4] In general, the results on the variables that proxy for attribution, authenticity, medium, and size are in line with the earlier findings. The other parameter estimates differ across movements. For example, a premium is paid for works with nudes only in Pop, while abstract art is priced exceptionally higher in Cubism, Futurism & Constructivism. With respect to the location of the sale, auctions at the large continental European houses generate premiums for the earliest art movements, such as Medieval & Renaissance and Baroque.

4. Robustness checks and extensions

In this section, we first test the robustness of our baseline return estimates to a number of alternative set-ups. In subsection 4.2, we explore the issue of changing tastes, using an adjacent period model. In subsection 4.3, we argue that masterpieces can be expected to outperform the rest of the market, and test this prediction empirically. Finally, because our empirical model induces a downward bias on the standard deviations, we desmooth our index in subsection 4.4.

4.1. Robustness checks

First, we recalculate our return estimates by running a hedonic regression on the logs of the nominal dollar prices, and then deflating the index. Although we think that it is better practice to start the analysis from deflated prices directly, it would corroborate our results if we found similar returns when using nominal prices and deflating afterwards. Panel A of Table 4 shows that this is the case.

[Insert Table 4 about here]

Second, we repeat our baseline analysis using a number of different set-ups: (i) excluding the topic dummies (as these may capture the subject matter rather imprecisely), (ii) excluding the more than 5,000 artists with fewer than 100 sales (as these artists are less liquid), and (iii) excluding Minimalism & Contemporary art (as selection and survivorship issues may be more relevant for more recent artists). Again, our results do not change materially.

Third, we test the robustness of our results to an alternative specification that substitutes the thousands of artist dummies with an objective measure for the perceived importance of an artist and the art historical relevance of his output. The publishers of Grove Art Online provided us with information on the length of each article in their database. This variable measures importance at the end of our time frame, and therefore it is not entirely exogenous. However, most articles in the database were written before the mid-1990s, attenuating the endogeneity bias. Besides, in a peer-reviewed reference work like Grove Art Online, endogeneity with respect to auction prices should matter less than in more popular resources. The artist with the highest word count (23,591) in our data set is Rembrandt van Rijn; a small fraction of our artists have a word count equal to zero. We include the word count variable with exponents one to four in our model to capture non-linearities in the relationship between reputation and price. The coefficients on the hedonic variables are in general similar to those reported earlier, and also the word count variables are highly significant (not reported). Panel A of Table 4 shows that the returns are in the same order of magnitude as before. Also, the R-squared is still above 42%. Since the endogeneity issue described above should be of more importance for living artists, who may rise to fame through increasing auction prices over their career, we repeat the analysis on the sales of dead artists' works only. The results demonstrate that this does not significantly alter our results.

4.2. Adjacent period model and changing tastes

A potential problem with the hedonic approach is that coefficients are constrained to be stable across the whole sample window. This is a strong assumption as, in reality, shadow prices of hedonic characteristics may change over time. Triplett (2004) argues that the "adjacent period approach" is a good alternative methodology. Instead of pooling all data, it considers two adjoining periods at a time. The resulting index thus not only controls for changes in quality, but also for fluctuations in the coefficients on the hedonic variables measuring quality. We apply the adjacent period model to our data set by performing a separate hedonic regression for every two adjoining years. We thus pool the data of 1957 and 1958, and estimate the return by including a year dummy variable for 1958, next to all other hedonic variables (except TEXTBOOK, which can only change in value in four different years). Then we pool the data of 1958 and 1959, and so forth.

Panel B of Table 4 shows that, at least since 1982, the adjacent year model generates a return estimate (4.60%) that is very similar to the one we obtained from the pooled data (4.55%). This lends further support to our benchmark index. For the longer period, the adjacent year model gives lower returns than our benchmark model, but this can largely be explained by the changing composition of the sample. While a pooled hedonic regression standardizes every observation based on all available data, an adjacent year regression can only use the information from two years. It is thus no surprise that we find the largest difference in return estimates between our baseline model and the adjacent period model in 1970, which is the first year for which also smaller auction houses are taken into account. The adjacent period model attributes too much of the difference in average prices between 1969 and 1970 to a year effect, leading to a downward bias in the estimated return. Also the much lower numbers of observations per year in the early decades hinder correct measurement of returns through an adjacent period model.

We find little time-series variation in the magnitudes of the coefficients on many of the hedonic variables, as also illustrated in Panel A of Figure 2. This figure shows the evolution between 1970 and 2007 of the coefficients on ATTRIBUTED, SIGNED, DATED, WATERCOLOR, DRAWING, and STUDY. The percentage premiums or discounts associated with these dummy variables have been relatively stable over time. In the next subsection, we will show that this does not hold for our top auction house dummies, which more clearly differentiate between higher-quality and lower-quality items in our sample.

[Insert Figure 2 about here]

Based on the average artist dummy coefficients across subsequent adjacent year models (not reported), we can calculate that Vincent Van Gogh was the most valuable artist in the 1960s, 1980s, 1990s, and 2000s, while George Seurat was the most expensive artist in the 1970s. Four artists feature in the top-ten of each decade: Van Gogh, Monet, Degas, and Cezanne. More generally, we examine persistence in tastes by calculating the correlation coefficients between the artist dummy coefficients across periods (not reported). The correlation between the first and the last adjacent year model equals 0.62. Over the last quarter century we observe a correlation coefficient of around 0.80 between start- and end-period coefficients. This number becomes even closer to one as shorter time frames are considered. Overall, this suggests that stylistic risk may mainly be an issue over the very long term.

4.3. The "masterpiece effect" or "superstar economics"?

Most existing research suggests that masterpieces underperform the rest of the art market (Ashenfelter and Graddy, 2003). This is surprising for two reasons. First, over the long term, art by better or more famous artists cannot systematically appreciate less in value than other art; otherwise, masterpieces would no longer command a premium. Second, the literature on superstar economics would predict higher returns for better art. In Rosen (1981), a small number of superstars earn large amounts of money, and increases in demand make the earnings distribution ever more skewed. A condition is that there is "imperfect substitution among quality differentiated goods" (Rosen, 1981). This is certainly the case in the art market: ten mediocre works do not add up to a single masterpiece. Insofar as the demand for art has increased over the last few decades—for example thanks to a rising population of art collectors (Goetzmann and Spiegel, 1995)—one can expect larger positive price changes for “superstar art” than for lesser-quality art.[5]

So why the discrepancy with the existing evidence on masterpiece effects in the art market? Much of the research suffers from the fact that masterpieces are identified endogenously, based on prices (Ashenfelter and Graddy, 2003). This can cause the sample to contain a large number of works for which random overbidding has taken place, and which may show mean reversion in prices afterwards. Also a survivorship bias may cause a negative masterpiece effect (Goetzmann, 1996): especially if only larger auction houses are taken into account, expensive items that drop in value are more likely to remain in the sample than lesser-quality works that underperform.

In this study, we test for the existence of a masterpiece effect using a non-price measure of quality. We first repeat our hedonic regression analysis on all sales by artists which were already included in the textbook ‘Gardner’s Art Through the Ages’ before the start of our time frame. This is an exogenous proxy for reputation. Second, we estimate an index based on sales of these artists’ output at Sotheby’s and Christie’s in London and New York, which often sell the best works. For the last quarter century, we repeat the analyses for artists included in the three editions of our art history textbook that were published before 1982.

The results in Panel C of Table 4 indicate that the artists mentioned in the first textbook outperformed the general art index by 1.10% per year since 1957 and by 1.33% on average since 1982. The same holds for the artists included in all three books published until 1980: we find an annualized return of 6.06% since 1982, compared to 4.55% for the general art index constructed previously. The indices based on the Sotheby’s and Christie’s sales show even more impressive returns. It thus pays off to invest in high-quality works.

Superstar economics also implies that we should observe increasing returns to “star quality” over time. We illustrate in Panel B of Figure 2 the trends of coefficients on the London top auction house dummies from the adjacent year models since 1970. For reasons of comparison, we also show the trend in the dummy for AUCTION_EUROPEAN. We see a steady increase in the relative gap

[5] Already at the beginning of the previous century, Marshall (1920) observed that the growth in wealth caused particularly strong rises in earnings by “painters and musicians of exceptional ability”: “there never was a time at which first-rate paintings sold so dearly”. In his seminal paper, Rosen (1981) argued that his model explained why “the best artists sell their works in the great markets of New York and Paris, not Cincinnati”. Gyourko et al. (2006) rely on superstar economics to rationalize why the gap in house prices between “superstar cities” and less attractive locations keeps increasing over time; the authors note that “living in a superstar city is like owning a luxury good”.

between prices paid for the best works and the rest of the market. This validates the importance of superstar effects in the art market.[6]

The economics of superstar art can partially explain the differences in results between previous papers and the present study. For example, Mei and Moses (2002) report a geometric average nominal return between 1957 and 1999 that is more than 4% higher than our baseline estimate. However, their focus is on resales of oil paintings at top auction houses in New York; our results suggest that this type of high-quality art may systematically enjoy substantially higher returns.

4.4. Desmoothing the index

Since our methodology aggregates sales information per calendar year, the first differences of the coefficients on our time dummies will suffer from spurious first-order autocorrelation and have understated standard deviations. We can unsmooth our index, a technique originated in the real estate literature, but later also applied to other asset classes (Kat and Lu, 2002; Campbell, 2008; Dimson and Spaenjers, 2011). Following Geltner (1993), we express the smoothed log return R_t^* (i.e., the first difference in hedonic coefficients) in period t as a weighted average of the true return R_t in the same period and the smoothed return in the previous period:

$$R_t^* = (1-\alpha)R_t + \alpha R_{t-1}^* . \tag{2}$$

Equation (2) can be inverted to recover the unsmoothed return series from the observed returns:

$$R_t = (R_t^* - \alpha R_{t-1}^*)/(1-\alpha) . \tag{3}$$

Based on Working (1960), we can calculate that taking a yearly average of daily prices induces spurious first-order serial correlation in returns of about 0.25. We therefore use this value for α in Equation (3), and reconstruct our return series. Panel D of Table 4 shows the results. Over the long run the desmoothed returns should be equal to the uncorrected returns, but over shorter terms small deviations can occur. More important, however, is to examine the differences in standard deviations. Over the period 1957–2007, the standard deviation of our desmoothed art index is now equal to 22.15% (instead of 16.68%). For an index of masterpieces, defined as before as all sales of works

[6] As a robustness check, we adapt Equation (1) to measure the time-varying impact of quality, using the word count variable introduced previously, in line with Krueger (2005). We observe that a word count that is 1,000 words higher is associated with 12.1% higher prices in 1957, but 32.4% higher prices in 2007. If we restrict our analysis to dead artists, a 1,000 words longer article is associated with a premium of 22.7% in 2007, up from 7.1% in 1957.

by artists included in the earliest art history textbook at top auction houses, the standard deviation even reaches 34.05%. Over the last quarter century, the standard deviation rises less sharply; for the all-art index, the new volatility equals 16.41% (instead of 14.39%).

5. Art and other assets

Now that we have calculated the returns on art, and have been able to correctly assess the true riskiness of art investments, we can compare the investment performance of art to that of a number of other asset classes. We also examine the degree to which the returns on art correlate with the returns on other assets. Next, in subsection 5.2, we investigate whether art has a place in a mean-variance efficient portfolio. We also turn the question around, and check whether an art collector should invest differently in financial assets than an investor with no interest in art. Finally, we study the impact of differences in transaction costs on our results in subsection 5.3.

5.1. Comparison of investment performance and correlation with other asset classes

We want to compare the performance of art investments, based on our desmoothed indices from the previous section, to that of other assets. We collect data from Global Financial Data on indices measuring total returns on U.S. T-bills, 10-year U.S. government bonds, Dow Jones (DJ) corporate bonds, the GFD global index for government bonds, S&P 500 stocks, the GFD world index for equity, gold prices, and the CRB commodity price index. We borrow data on real estate prices in the U.S. from Shiller (2009). Panel A of Table 5 shows the average yearly real returns and volatility calculated over the periods 1957–2007 and 1982–2007. The same table also presents the ex-post Sharpe ratios, using the returns on T-bills as a measure of the risk-free rate.

[Insert Table 5 about here]

Over the longer time frame, the art index clearly underperforms stocks. The S&P 500 and the GFD global equity index have appreciated at average real rates of 7.79% and 6.04%, respectively, while our art index increased by 4.18% annually over the same period (5.90% for masterpieces). Also the reward-to-variability, as measured by the Sharpe ratio, is higher for stocks than for art. The art indices have a higher average return since 1957 than our different bond indices, but the Sharpe ratios only surpasses that of U.S. government bonds. This has mainly to do with the high volatility of our art indices; our masterpiece index has the highest standard deviation of all asset classes under consideration. Nevertheless, compared to the other tangible assets in Table 5 (gold, commodities, and real estate), art does relatively well.

Very similar conclusions hold over the shorter time frame (since 1982). In terms of returns, art is somewhat comparable to bonds, but the financial risk that goes with an investment in the art market is relatively high. However, art seems a more attractive investment than other real asset classes.

Panel B of Table 5 shows the correlation matrix for the real returns of all asset categories for the 1957–2007 time frame. We find very low positive correlation (0.10 or less) between art on the one hand and bills and bonds on the other. The correlation between our art indices and the gold, commodity, and real estate price indices is somewhat stronger; we find correlation coefficients between our all-art index and real estate and between the masterpiece index and commodities that are around 0.30 and statistically significant at the five percent level. We can observe even higher correlations between art and stocks. Especially the correlation of the art indices with the global stock index is high (correlation coefficients of 0.47 and 0.38), but also the correlation between art and the S&P 500 is statistically significant. This contrasts with previous research on smaller samples (Mei and Moses, 2002; Pesando and Shum, 2008; Campbell, 2008), which has reported lower correlations between art and equity investments.

5.2. Portfolio analysis

We now examine whether art has a place in an investor's optimal portfolio. Panel A of Table 6 shows the composition of the tangency portfolio under a number of different scenarios, based on the historical returns reported before. As before, the return on T-bills is taken as the risk-free rate. Furthermore, we do not allow short sales in any asset. We perform the analysis both starting from the benchmark all-art index and from the masterpiece index.

[Insert Table 6 about here]

We first investigate the portfolio composition excluding art investments. We observe that the largest fractions of the investor's wealth are invested in U.S. corporate bonds and stocks, and in commodities. Additionally, a small share is invested in gold. We then add art to the set of investable assets. When the all-art index is considered, 3.13% is invested in art. This percentage rises to 7.51%

in the case of masterpieces.[7] At the same time, we see small decreases in the importance of U.S. stocks and—especially when the masterpiece index is used—commodities.

Art collectors may be more interested in the optimal composition of their portfolio, conditional on a certain investment in art. Therefore, we also examine the changes in the tangency portfolio imposing a minimum allocation to art / masterpieces of 20% or 40%. The results in Panel A of Table 6 show that art crowds out investments in commodities first and corporate bonds afterwards. When 40% of an investor's wealth goes to art, it may be efficient to invest the remainder in U.S. stocks only.

5.3. The impact of transaction costs

Up to now, our analysis has not taken into account differences in transaction costs. These costs may matter though, especially given their magnitude for art transactions. Auction houses have historically charged sellers a "commission" in exchange for their services. In the early 1970s, auction houses also started to ask a "premium" from buyers (Watson, 1992). For most of our time frame, auction houses charged buyer's premiums and seller's commissions of around 10% (Pesando, 1993; Ashenfelter and Graddy, 2003). In recent years, the importance of the buyer's premium has grown, while important consignors have been able to obtain lower (sometimes even negative) commission rates. On average, however, we can still assume a one-way transaction cost of 10%. We abstract from storage and insurance costs.

Financial assets mostly have lower costs per transaction, although estimates of average costs vary with asset class, investor type, transaction size, time frame, etc. With respect to equities, Lesmond et al. (1999) estimate average round-trip costs for large-size NYSE and AMEX firms to be around 1.23% between 1963 and 1990, assuming that transaction costs should be reflected in prices. Jones (2002) finds average one-way transaction costs, measured as half the bid-ask spread plus one-way commissions, of 0.84% for U.S. stocks for the period 1925–2000. We will use the latter, more recent estimate. International diversification through investment in international equities raises costs. Perold and Sirri (1997) find average costs for trades by U.S. investors in international stocks to be more than 1% higher than those involving U.S. equities. Therefore, we assume a one-way transaction cost of 2% for global equities.

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[7] We test for the significance in the increase in Sharpe ratios, using the robust inference methods developed by Ledoit and Wolf (2008). We cannot reject the null hypothesis of equality in Sharpe ratios.

Trading costs are lower for bonds. Schultz (2001) finds an average round-trip transaction cost of 0.27% across trades (in the late 1990s) of corporate bonds by institutional investors. In contrast, trading costs are close to zero for U.S. Treasury bills (Amihud and Mendelson, 1991). Chakravarty and Sarkar (2003) find an average bid-ask spread for Treasury bonds of 0.08%. We thus assume one-way transaction costs of zero for T-bills, and of 0.04% for U.S. government bonds. As before, investment in international government bonds must induce extra costs. We assume one-way transaction costs to be equal to 0.25%.

Finding a good estimate of transaction costs can be even more problematic in the case of physical assets. For gold, we follow Solt and Swanson (1981) and assume a one-way transaction cost of 1%. As in the case of art, we abstract from insurance and storage costs. For commodities, investment is now possible through an exchange-traded fund that seeks to replicate the performance of the CRB price index. The (yearly) expense ratio of the Jefferies | TR/J CRB Global Commodity Equity Index Fund is equal to 0.65%, which have to be added to the one-way transaction costs for U.S. equities. We assume the same cost structure for real estate, for which similar securities exist.[8]

If we take the perspective of a buy-and-hold investor, the optimal portfolio will not only depend on returns and the covariance matrix, but also on the investment horizon. Indeed, large transaction costs will play a smaller role when they can be amortized over many years. Panel B of Table 6 shows the share of each asset in the tangency portfolio for different investment horizons, under the assumptions on transaction costs outlined in the previous paragraphs.

The table shows that art plays nearly no role in a portfolio when the investment horizon is five years or less. For longer time horizons, however, an investor may want to put part of his wealth in masterpieces. When considering a horizon of 25 years, the fraction invested in masterpieces is 8.15%. As illustrated earlier, it makes less economic sense to invest in works of average quality. This implies that investing in art may only be attractive to investors who can afford to buy masterpieces even when allocating just a relatively small fraction of their wealth to art.

The results are not sensitive to alternative assumptions about transaction costs. Even when the costs for government bonds are put equal to zero or the costs for global stocks are equalized to that of their U.S. counterparts, these asset categories do not enter the efficient portfolio, ceteris paribus.

[8] One could also estimate the transaction costs associated with actual purchases and sales of commodities and real estate. However, yearly operating, storage, and insurance costs and other expenses should then also be taken into account, since these assets cannot so easily be locked away as art or gold. On the other hand, an investor in real estate may also earn rental income.

Assuming higher percentage costs for U.S. stocks (and thus also for commodities and real estate) only marginally affects the importance of art in the portfolio. For example, if one assumes one-way transaction costs of 2% (instead of 0.84%), the share of masterpieces increases by 2.01, 1.21, and 0.51 percentage points when the investment horizon is 5 years, 10 years, and 25 years, respectively. This is mainly due to a decrease in the importance of commodities. As before, art and commodities thus seem to be substitutes in an optimal portfolio.

6. Conclusions and discussion

Recent research has shown that consumption services may dominate the art purchase decision for a representative agent (Mandel, 2009, 2010). However, at the same time, many collectors are acutely attuned to the financial value of their assets (Burton and Jacobsen, 1999). This underlines the importance of an accurate measure of the financial returns to art. Therefore, in this paper, we have investigated the historical investment performance of art, by applying an extensive hedonic regression framework to a data set of more than one million paintings and works on paper.

We show that the reputation of the artist, the strength of the attribution to an artist, and the topic of the work are important determinants of the final price. Next, our regression results confirm previous findings that the size, the medium, and the degree of visible authenticity (signature, date) influence the price outcome. Finally, we find that differences in prices are strongly correlated with variations in the timing and location of the sale.

The coefficients on the year dummies in our hedonic model are used to build a general art price index. Based on this index, we conclude that art prices have increased by a moderate 4.04%, annually, in real USD terms between 1957 and 2007. During art market booms, however, prices can skyrocket. For example, between 2002 and 2007, our index shows a real return of 11.65% per year. This helps to explain the attention to ‘art as an investment’ in recent years. Over the last half century, oil paintings have much more increased in value than works on paper. We also perform an analysis of thirteen art movements, and find that post-war art movements have outperformed earlier paradigms. We find clear evidence of a positive masterpiece effect: better art makes a better investment. Cross-sectional variation in average returns can partially explain the differences in results between previous papers, which have mostly used smaller samples of high-quality paintings sold at top auction houses, and the present study.

Although even masterpieces have a lower average return and higher volatility than stocks, art's risk-return profile is more attractive than that of other real assets. Moreover, despite the substantial transaction costs related to art investments, high-end art may have its place in the portfolio of affluent investors with a long-term horizon.

We finally want to note that we have taken the perspective of a USD investor. One can repeat the analysis from a different point of view, and investigate how the results change. As a simple exercise, we rerun our regression based on transaction prices in real GBP instead of USD. The impact of changing the currency perspective on the return estimates can be significant. While the USD-index has increased at a yearly average of 4.55% between 1982 and 2007, the GBP-index has appreciated by only 3.23% per year. For shorter time frames, the discrepancy can be even larger. In real British pounds, the art market has yet to return to the record highs of the late 1980s. It thus seems that some of the art hype in recent years finds its origins in the fact that (record) art prices are mostly measured in USD.

Appendix A—Compilation of list of artists

We start by consulting Grove Art Online [http://www.oxfordartonline.com], a database published by Oxford University Press that contains all articles of the 34-volume 'The Dictionary of Art' (1996) as well as 'The Oxford Companion to Western Art' (2001). We select all 9,775 individual artists from the categories 'graphic arts', 'painting and drawing', and 'printmaking'. We subsequently expand our set of artists by means of another online database, Artcyclopedia [http://www.artcyclopedia.com]. This raises the number of artists to 10,211.

We then compose a list of thirteen art movements: Medieval & Renaissance; Baroque; Rococo; Neoclassicism; Romanticism; Realism; Impressionism & Symssssssssssssbolism; Fauvism & Expressionism; Cubism, Futurism & Constructivism; Dada & Surrealism; Abstract Expressionism; Pop; and Minimalism & Contemporary. When possible, we classify our artists into one of these categories, based on the 'Styles and Cultures' from Grove Art Online and 'Art Movements' of Artcyclopedia. We can put 4,132 artists into at least one art movement.

Finally, we expand our data set in two more ways, to correct for the possible underrepresentation of modern and contemporary art. We compare the index of the influential book 'Modern Art' (Britt, 1989) to our data set and add 62 modern artists to our list (with classification). The book also enables us to assign another 87 artists not yet classified to a specific art movement. Next, in order to have a representative and up-to-date sample of contemporary artists, we consult Wikipedia [http://en.wikipedia.org/wiki/List_of_contemporary_artists]. We can add 169 artists, bringing our list to 10,442 artists in total; 40 other artists can now be classified in Minimalism & Contemporary.

Appendix B—Titles and topics

We use the first word(s) of the title to classify works in topic categories. Most titles in our database are in English, but we also include French keywords in our analysis. We avoid search strings that can be used in different contexts.

Sometimes we only search for titles no longer than one word or in which the word is followed by a space (e.g., “cat_”) to avoid misclassifications due to longer words with identical first characters (e.g., “catholic”).

These are the topic categories, along with their search strings: ABSTRACT (“abstract”, “composition”), ANIMALS (“horse”, “cheval”, “chevaux”, “cow_”, “cows”, “vache”, “cattle”, “cat_”, “cats”, “chat_ “, “dog_”, “dogs”, “chien”, “sheep”, “mouton”, “bird”, “oiseau”), LANDSCAPE (“landscape”, “country landscape”, “coastal landscape”, “paysage”, “seascape”, “sea_”, “mer_”, “mountain”, “river”, “riviere”, “lake”, “lac_”, “valley”, “vallee”), NUDE (“nude”, “nu_”, “nue_”), PEOPLE (“people”, “personnage”, “family”, “famille”, “boy”, “garcon”, “girl”, “fille”, “man_”, “men_”, “homme”, “woman”, “women”, “femme”, “child”, “enfant”, “couple”, “mother”, “mere_”, “father”, “pere_”, “lady”, “dame”), PORTRAIT (“portrait”), RELIGION (“jesus”, “christ_”, “apostle”, “ange_”, “angel”, “saint_”, “madonna”, “holy_”, “mary magdalene”, “annunciation”, “annonciation”, “adoration”, “adam and eve”, “adam et eve”, “crucifixion”, “last supper”), SELF-PORTRAIT (“self-portrait”, “self portrait”, “auto-portrait”, “autoportrait”), STILL_LIFE (“still life”, “nature morte”, “bouquet”), UNTITLED (“untitled”, “sans titre”), URBAN (“city”, “ville”, “town”, “village”, “street”, “rue”, “market”, “marche”, “harbour”, “port_”, “paris”, “london”, “londres”, “new york”, “amsterdam”, “rome_”, “venice”, “venise”).

Appendix C—Important European and American auction houses

The AUCTION_EUROPEAN category includes all sales by: Lyon & Turnbull (Scotland), Francis Briest / Artcurial Briest (France), Ader, Picard & Tajan / Ader & Tajan / Tajan (France), Bruun Rasmussen (Denmark), Dorotheum (Austria), Koller (Switzerland), Lempertz (Germany), Neumeister (Germany), Finarte (Italy), Bukowskis (Sweden), Stockholms Auktionsverk (Sweden). The AUCTION_AMERICAN category includes all sales by: Butterfields (until 2002), Swann Auction Galleries, Skinner, Doyle New York, Freeman’s, Leslie Hindman.

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Table 1—Descriptive statistics hedonic variables

Table 1 displays the descriptive statistics for the hedonic variables used in this study. TEXTBOOK is a dummy variable that equals one if the artist was included in the last edition of 'Gardner's Art Through the Ages' (1926, 1959, 1980, 1996, or 2004) prior to the sale. EXHIBITION is a dummy variable that equals one once the artist has exhibited at the Documenta art exhibition in Kassel, Germany. DECEASED equals one in case the artist is dead at the time of the sale. The attribution dummies ATTRIBUTED, STUDIO, CIRCLE, SCHOOL, AFTER, and STYLE equal one if the auction catalogue identifies the work as being "attributed to" the artist, from the "studio" of that artist, from the "circle" of the artist, from the artist's "school", "after" the artist, or "in the style of" the artist, respectively. The authenticity dummies SIGNED and DATED take the value of one if the work carries a signature of the artist or is dated, respectively. The medium dummies OIL, WATERCOLOR, and DRAWING indicate whether the work is an oil painting, a watercolor (including gouaches), or another work on paper. The variables HEIGHT and WIDTH measure the height and the width of the work in inches. The topic dummies are based on the first word(s) of the title of the work (cf. Appendix B). The month dummies indicate the month of the sale. The auction house dummies SOTH_LONDON, SOTH_NY, SOTH_OTHER, CHR_LONDON, CHR_NY, CHR_OTHER, BON_LONDON, BON_OTHER, PHIL_LONDON, and PHIL_OTHER equal one if the sale takes place at Sotheby's London, Sotheby's New York, another branch of Sotheby's, Christie's London, Christie's New York, another branch of Christie's, Bonhams London, another office of Bonhams, Phillips London, or another sales room of Phillips, respectively. AUCTION_EUROPEAN and AUCTION_AMERICAN are dummy variables that equal one if the sale takes place at a large Continental European or a large American auction house, respectively (cf. Appendix C). For each variable, we report the number of observations (N), the mean, and the standard deviation (S.D.). For dummy variables, we also show the number of zeros and ones.

	N	Mean	S.D.	0	1
Artist characteristics					
TEXTBOOK	1,088,709	0.1218	0.3271	956,096	132,613
EXHIBITION	1,088,709	0.2118	0.4086	858,118	230,591
DECEASED	1,088,709	0.8810	0.3238	992,796	95,913
Work characteristics					
Attribution dummies					
ATTRIBUTED	1,088,709	0.0435	0.2040	1,041,361	47,348
STUDIO	1,088,709	0.0051	0.0716	1,083,104	5,605
CIRCLE	1,088,709	0.0229	0.1496	1,063,778	24,931
SCHOOL	1,088,709	0.0065	0.0802	1,081,663	7,046
AFTER	1,088,709	0.0101	0.1002	1,077,668	11,041
STYLE	1,088,709	0.0288	0.1671	1,057,407	31,302
Authenticity dummies					
SIGNED	1,088,709	0.5900	0.4918	446,375	642,334
DATED	1,088,709	0.3292	0.4699	730,275	358,434
Medium dummies					
OIL	1,088,709	0.6025	0.4894	432,813	655,896
WATERCOLOR	1,088,709	0.1739	0.3790	899,358	189,351
DRAWING	1,088,709	0.2236	0.4167	845,247	243,462
Size variables					
HEIGHT	1,078,702	20.6597	14.8467		
WIDTH	1,078,549	21.5984	15.8748		
Topic dummies					
STUDY	1,088,709	0.0152	0.1225	1,072,127	16,582
ABSTRACT	1,088,709	0.0255	0.1576	1,060,960	27,749
ANIMALS	1,088,709	0.0108	0.1033	1,076,970	11,739
LANDSCAPE	1,088,709	0.0430	0.2028	1,041,934	46,775
NUDE	1,088,709	0.0082	0.0903	1,079,757	8,952
PEOPLE	1,088,709	0.0377	0.1906	1,047,628	41,081
PORTRAIT	1,088,709	0.0619	0.2410	1,021,273	67,436
RELIGION	1,088,709	0.0161	0.1257	1,071,234	17,475
SELF-PORTRAIT	1,088,709	0.0030	0.0544	1,085,479	3,230
STILL_LIFE	1,088,709	0.0244	0.1543	1,062,130	26,579

UNTITLED	1,088,709	0.0287	0.1670	1,057,438	31,271
URBAN	1,088,709	0.0137	0.1164	1,073,761	14,948
Sale characteristics					
Month dummies					
JANUARY	1,088,709	0.0287	0.1670	1,057,438	31,271
FEBRUARY	1,088,709	0.0450	0.2074	1,039,667	49,042
MARCH	1,088,709	0.0916	0.2884	989,021	99,688
APRIL	1,088,709	0.0862	0.2807	994,864	93,845
MAY	1,088,709	0.1358	0.3426	940,857	147,852
JUNE	1,088,709	0.1389	0.3459	937,442	151,267
JULY	1,088,709	0.0547	0.2275	1,029,109	59,600
AUGUST	1,088,709	0.0132	0.1141	1,074,345	14,364
SEPTEMBER	1,088,709	0.0325	0.1773	1,053,329	35,380
OCTOBER	1,088,709	0.0904	0.2868	990,270	98,439
NOVEMBER	1,088,709	0.1674	0.3733	906,483	182,226
DECEMBER	1,088,709	0.1155	0.3196	962,974	125,735
Auction house dummies					
SOTH_LONDON	1,088,709	0.1220	0.3273	955,868	132,841
SOTH_NY	1,088,709	0.0868	0.2816	994,167	94,542
SOTH_OTHER	1,088,709	0.0553	0.2285	1,028,541	60,168
CHR_LONDON	1,088,709	0.0945	0.2925	985,848	102,861
CHR_NY	1,088,709	0.0621	0.2413	1,021,149	67,560
CHR_OTHER	1,088,709	0.0711	0.2570	1,011,321	77,388
BON_LONDON	1,088,709	0.0106	0.1023	1,077,189	11,520
BON_OTHER	1,088,709	0.0058	0.0759	1,082,400	6,309
PHIL_LONDON	1,088,709	0.0151	0.1220	1,072,251	16,458
PHIL_OTHER	1,088,709	0.0093	0.0960	1,078,571	10,138
AUCTION_EUROPEAN	1,088,709	0.1364	0.3432	940,173	148,536
AUCTION_AMERICAN	1,088,709	0.0189	0.1361	1,068,160	20,549

Table 2—Results baseline hedonic regression

Table 2 presents the hedonic regression results for the baseline model including all observations. The model is estimated using OLS. The dependent variable is the natural log of the price in 2007 USD. The independent variables are defined in Table 1. For each variable, we report the coefficient, the standard deviation (S.D.), and the *t*-statistic. We also show the price impact, which can be calculated by taking the exponent of the coefficient and subtracting one. The number of observations and the *R*-squared (R2) are presented at the bottom of the table.

	Coefficient	S.D.	t-statistic	Price impact
Year dummies	[included]			
Artist characteristics				
Artist dummies	[included]			
TEXTBOOK	0.1263	0.0065	19.51	13.46%
Work characteristics				
Attribution dummies				
ATTRIBUTED	-0.7365	0.0050	-146.91	-52.12%
STUDIO	-0.7977	0.0134	-59.33	-54.96%
CIRCLE	-1.0490	0.0068	-155.21	-64.97%
SCHOOL	-1.4152	0.0120	-118.03	-75.71%
AFTER	-1.8850	0.0104	-180.75	-84.82%
STYLE	-1.5688	0.0064	-244.54	-79.17%
Authenticity dummies				
SIGNED	0.2703	0.0027	99.46	31.04%
DATED	0.1706	0.0026	66.74	18.60%
Medium dummies				
OIL	[left out]			
WATERCOLOR	-0.7144	0.0033	-218.49	-51.05%
DRAWING	-1.1005	0.0030	-363.62	-66.73%
Size variables				
HEIGHT	0.0205	0.0002	117.55	2.07%
WIDTH	0.0250	0.0002	152.56	2.53%
HEIGHT_2	-0.0001	0.0000	-58.35	-0.01%
WIDTH_2	-0.0001	0.0000	-85.57	-0.01%
Topic dummies				
STUDY	-0.2049	0.0078	-26.32	-18.53%
ABSTRACT	-0.0780	0.0068	-11.46	-7.50%
ANIMALS	-0.1703	0.0094	-18.08	-15.66%
LANDSCAPE	-0.1320	0.0048	-27.70	-12.37%
NUDE	-0.1645	0.0105	-15.64	-15.17%
PEOPLE	-0.0372	0.0050	-7.48	-3.65%
PORTRAIT	-0.2278	0.0050	-45.76	-20.37%
RELIGION	-0.1114	0.0082	-13.64	-10.54%
SELF-PORTRAIT	0.1202	0.0171	7.03	12.77%
STILL_LIFE	0.0410	0.0067	6.15	4.18%
UNTITLED	-0.1639	0.0065	-25.32	-15.12%
URBAN	0.0409	0.0081	5.08	4.17%
Sale characteristics				
Month dummies				
JANUARY	[left out]			
FEBRUARY	-0.1209	0.0072	-16.90	-11.39%
MARCH	0.0318	0.0065	4.91	3.23%
APRIL	0.0859	0.0065	13.17	8.97%
MAY	0.1325	0.0062	21.41	14.16%
JUNE	0.1430	0.0063	22.85	15.37%
JULY	0.0843	0.0070	12.06	8.80%
AUGUST	-0.0629	0.0101	-6.20	-6.09%
SEPTEMBER	-0.1599	0.0077	-20.90	-14.78%
OCTOBER	0.0007	0.0065	0.10	0.07%
NOVEMBER	0.1821	0.0061	29.72	19.98%
DECEMBER	0.1517	0.0064	23.84	16.38%

Auction house dummies				
SOTH_LONDON	0.6324	0.0037	173.36	88.22%
SOTH_NY	0.7195	0.0041	175.29	105.35%
SOTH_OTHER	0.3107	0.0046	67.89	36.44%
CHR_LONDON	0.6468	0.0039	165.48	90.94%
CHR_NY	0.6685	0.0046	145.46	95.12%
CHR_OTHER	0.1540	0.0042	36.91	16.65%
BON_LONDON	0.1180	0.0094	12.57	12.52%
BON_OTHER	-0.1193	0.0125	-9.53	-11.24%
PHIL_LONDON	0.2170	0.0079	27.36	24.23%
PHIL_OTHER	0.1164	0.0099	11.73	12.35%
AUCTION_EUROPEAN	0.1308	0.0033	39.59	13.98%
AUCTION_AMERICAN	-0.0968	0.0074	-13.08	-9.22%
Number of observations	1,078,482			
R2	0.6411			

Table 3—Returns on art and art movements

Table 3 displays the returns on art, on each medium, and on each individual art movement since 1957 (except for the last three movements) and since 1982. The geometric mean real returns and the standard deviations (S.D.) are calculated using the relevant hedonic price indices. The nominal returns are obtained by correcting the indices for the year-to-year changes in the U.S. CPI series. The table also includes the number of observations (N) and the *R*-squared (R2) for each model.

			Real returns				Nominal returns			
	N	R2	1957-2007		1982-2007		1957-2007		1982-2007	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Art	1,078,482	0.6411	4.04%	16.68%	4.55%	14.39%	8.29%	16.76%	7.80%	14.92%
Oil	650,563	0.6502	4.58%	17.64%	5.10%	14.43%	8.86%	17.72%	8.36%	14.97%
Watercolor	187,612	0.6655	3.44%	15.36%	3.54%	14.35%	7.67%	15.61%	6.75%	14.83%
Drawing	240,307	0.6352	2.40%	18.38%	3.85%	14.42%	6.59%	18.64%	7.08%	14.94%
Med. & Ren.	30,806	0.5417	3.49%	21.23%	5.84%	17.02%	7.72%	21.27%	9.13%	17.15%
Baroque	124,617	0.5262	4.48%	20.15%	4.77%	11.79%	8.75%	20.14%	8.02%	12.10%
Rococo	30,292	0.5168	3.69%	26.95%	4.02%	11.53%	7.93%	26.93%	7.25%	11.99%
Neoclassicism	12,601	0.5341	5.68%	33.64%	5.16%	16.76%	10.01%	34.05%	8.42%	17.27%
Romanticism	41,897	0.5838	3.96%	23.07%	3.85%	12.33%	8.21%	23.24%	7.07%	12.66%
Realism	60,820	0.6658	2.70%	25.31%	3.57%	13.82%	6.89%	25.72%	6.78%	14.36%
Impr. & Symb.	95,829	0.7255	3.84%	20.11%	4.00%	15.79%	8.08%	20.44%	7.23%	16.35%
Fauv. & Expr.	73,543	0.7392	4.05%	21.13%	3.81%	17.80%	8.30%	21.46%	7.03%	18.34%
Cubism etc.	49,056	0.7352	5.07%	20.20%	5.49%	19.32%	9.37%	20.86%	8.77%	20.16%
Dada & Surr.	49,697	0.7256	5.46%	24.11%	5.03%	18.31%	9.77%	25.04%	8.29%	19.13%
Abst. Expr.	35,960	0.7056	N.A.	N.A.	7.08%	21.93%	N.A.	N.A.	10.40%	23.01%
Pop	18,924	0.7153	N.A.	N.A.	9.01%	26.51%	N.A.	N.A.	12.40%	27.57%
Min. & Cont.	19,472	0.7352	N.A.	N.A.	7.13%	23.54%	N.A.	N.A.	10.46%	24.59%

Table 4—Robustness checks and extensions

Panel A of Table 4 displays the results of the robustness checks described in subsection 4.1. Panel B shows the average returns using the adjacent period model outlined in subsection 4.2. Panel C tests the hypothesis of a positive masterpiece effect, following subsection 4.3. In Panels A through C, the geometric mean real returns and the standard deviations (S.D.) are calculated using the relevant hedonic price indices. Panel D shows the average returns and standard deviations after desmoothing the baseline log return series, as explained in subsection 4.4. The table also includes the number of observations (N) and the *R*-squared (R2) for each model.

	N	R2	Real returns			
			1957-2007		1982-2007	
			Mean	S.D.	Mean	S.D.
Art (baseline results)	1,078,482	0.6411	4.04%	16.68%	4.55%	14.39%
Panel A: Robustness checks						
- Use nominal prices in hedonic regression	1,078,482	0.6656	4.03%	16.83%	4.57%	14.46%
- Delete topic dummies from model	1,078,482	0.6395	4.02%	16.73%	4.53%	14.39%
- Exclude artists with less than 100 sales	935,736	0.6457	4.04%	16.57%	4.57%	14.69%
- Exclude Minimalism & Contemporary	1,059,010	0.6390	4.00%	16.63%	4.48%	14.26%
- Replace artist dummies with word count	1,078,482	0.4281	3.51%	19.34%	4.74%	15.54%
- Replace artist dummies with word count (dead artists)	950,037	0.4278	3.41%	20.42%	4.56%	15.23%
Panel B: Adjacent period model	N.A.	N.A.	2.62%	16.50%	4.60%	13.62%
Panel C: Masterpiece effect						
- First textbook	42,924	0.6907	5.14%	22.39%	5.88%	16.82%
- First textbook + top auction houses	25,894	0.6905	5.70%	24.52%	6.75%	19.98%
- First three textbooks	37,215	0.6834	N.A.	N.A.	6.06%	17.21%
- First three textbooks + top auction houses	22,904	0.6798	N.A.	N.A.	6.81%	20.24%
Panel D: Desmoothed return series						
- Art	1,078,482	0.6411	4.18%	22.15%	5.09%	16.41%
- Masterpieces (first textbook + top auction houses)	25,894	0.6905	5.90%	34.05%	7.44%	26.43%

Table 5—Art versus other assets

Panel A of Table 5 displays the geometric mean real returns on art, masterpieces, and on a range of other assets since 1957 and since 1982. Masterpieces are all works sold at Sotheby's and Christie's in London and New York by artists which were included in the textbook 'Gardner's Art Through the Ages' at the start of our time frame (cf. subsection 4.3). The real returns on art are calculated using the desmoothed hedonic price indices (cf. subsection 4.4). The return data for the financial assets, gold, and commodities come from Global Financial data. Data for U.S. real estate come from Shiller (2009). The panel also includes the standard deviation (S.D.) of the returns, and the Sharpe ratio. The return on T-bills is used as a proxy for the risk-free rate. Panel B shows the correlations between the real returns since 1957. Correlation coefficients that are significantly different from zero at the five percent level are displayed in bold.

Panel A: Comparison of investment performance

	Real returns					
	1957-2007			1982-2007		
	Mean	S.D.	Sharpe	Mean	S.D.	Sharpe
Art	4.18%	22.15%	0.1242	5.09%	16.41%	0.1841
Masterpieces	5.90%	34.05%	0.1307	7.44%	26.43%	0.2042
T-bills	1.38%	2.11%	N.A.	2.09%	1.95%	N.A.
U.S. government bonds	2.60%	10.98%	0.1224	6.75%	12.69%	0.3979
DJ corporate bonds	3.95%	10.09%	0.2751	7.74%	10.99%	0.5617
Global government bonds	2.92%	9.02%	0.1834	6.64%	9.94%	0.4906
S&P 500 stocks	7.79%	17.03%	0.3948	13.64%	16.69%	0.7301
Global stocks	6.04%	16.35%	0.2954	9.92%	17.53%	0.4655
Gold	1.84%	24.86%	0.0065	-0.47%	14.59%	-0.1771
Commodities	2.66%	12.41%	0.0881	1.70%	10.46%	-0.0448
U.S. real estate	1.06%	4.06%	-0.0770	2.41%	4.73%	0.0428

Panel B: Correlations of returns

	Art	Masterpieces	T-bills	U.S. government bonds	DJ corporate bonds	Global government bonds	S&P 500 stocks	Global stocks	Gold	Commodities	U.S. real estate
Art	1.00										
Masterpieces	**0.86**	1.00									
T-bills	0.08	0.10	1.00								
U.S. government bonds	0.08	0.01	**0.43**	1.00							
DJ corporate bonds	0.14	0.07	**0.41**	**0.95**	1.00						
Global government bonds	0.17	0.11	**0.37**	**0.93**	**0.92**	1.00					
S&P 500 stocks	**0.32**	0.27	**0.38**	**0.48**	**0.49**	**0.47**	1.00				
Global stocks	**0.47**	**0.38**	**0.30**	**0.40**	**0.41**	**0.47**	**0.88**	1.00			
Gold	0.23	0.25	**-0.47**	-0.10	-0.10	0.00	-0.03	0.16	1.00		
Commodities	0.27	**0.35**	**-0.30**	-0.25	-0.15	-0.17	-0.04	0.08	**0.54**	1.00	
U.S. real estate	**0.28**	0.16	-0.22	0.05	0.06	0.13	-0.08	0.07	0.10	0.12	1.00

Table 6—Portfolio analysis

Panel A of Table 6 displays the fractions of wealth invested in art or masterpieces, and in a range of other assets in the tangency portfolio, based on historical return data since 1957. Masterpieces (MP) are all works sold at Sotheby's and Christie's in London and New York by artists which were included in the textbook 'Gardner's Art Through the Ages' at the start of our time frame (cf. subsection 4.3). The real returns on art are calculated using the desmoothed hedonic price indices (cf. subsection 4.4). The return data for the financial assets, gold, and commodities come from Global Financial data. Data for U.S. real estate come from Shiller (2009). Short sales are not allowed for any asset class. The geometric mean real return, the standard deviation (S.D.) of the returns, and the Sharpe ratio are presented at the bottom of the table. The return on T-bills is used as a proxy for the risk-free rate. The analysis assumes different constraints on the importance of art in the investor's portfolio. Panel B repeats the analysis, taking into account differences in annualized transaction costs, assuming different time horizons but no constraint on the investment in art. More information on transaction costs can be found in subsection 5.3 of this paper.

Panel A: Portfolio analysis before transaction costs (under differerent assumptions on the fraction invested in art)

	% in tangency portfolio						
	0% in art	No constraint		At least 20% in art		At least 40% in art	
		Art	MP	Art	MP	Art	MP
Art		3.13%		20.00%		40.00%	
Masterpieces			7.51%		20.00%		40.00%
U.S. government bonds	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DJ corporate bonds	25.69%	25.50%	27.25%	17.08%	20.45%	0.00%	0.00%
Global government bonds	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
S&P 500 stocks	44.82%	43.48%	42.00%	46.45%	50.20%	59.17%	60.00%
Global stocks	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gold	4.20%	3.88%	3.40%	3.21%	3.44%	0.83%	0.00%
Commodities	25.29%	24.02%	19.85%	13.26%	5.91%	0.00%	0.00%
U.S. real estate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mean real return	6.23%	6.25%	6.67%	6.86%	8.06%	8.02%	9.96%
S.D.	9.56%	9.57%	10.17%	11.32%	13.34%	15.28%	18.95%
Sharpe ratio	0.5055	0.5066	0.5183	0.4825	0.4997	0.4337	0.4518

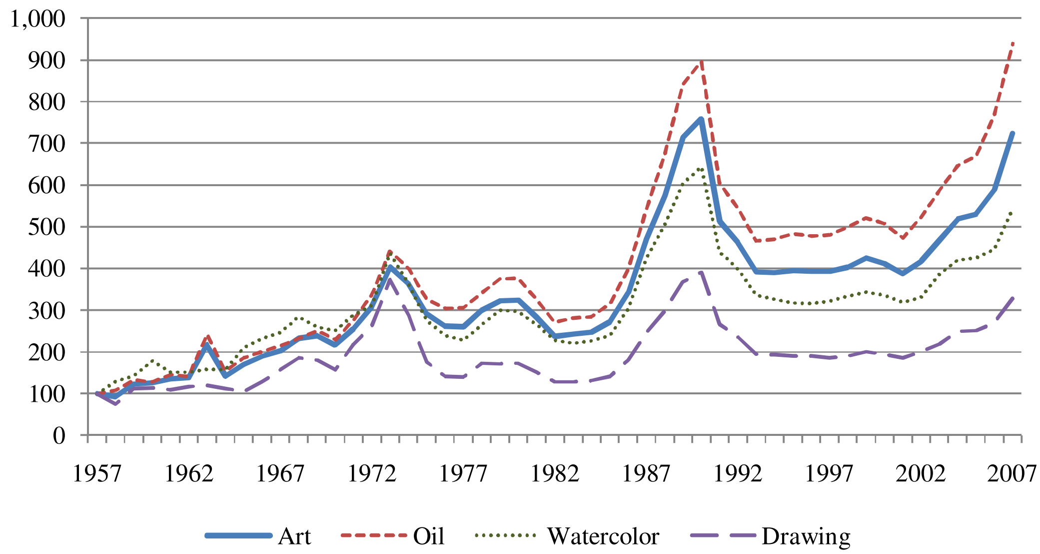
Panel B: Portfolio analysis after transaction costs (under different assumptions on the time horizon)

	% in tangency portfolio							
	Horizon = 1 y.		Horizon = 5 y.		Horizon = 10 y.		Horizon = 25 y.	
	Art	MP	Art	MP	Art	MP	Art	MP
Art	0.00%		0.00%		0.00%		0.84%	
Masterpieces		0.00%		0.96%		5.58%		8.15%
U.S. government bonds	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DJ corporate bonds	41.18%	41.18%	29.13%	29.33%	27.92%	29.10%	27.19%	28.98%
Global gvmt. bonds	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
S&P 500 stocks	51.84%	51.84%	51.03%	50.69%	50.46%	48.51%	49.78%	47.29%
Global stocks	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gold	6.98%	6.98%	8.50%	8.42%	8.27%	7.78%	8.05%	7.42%
Commodities	0.00%	0.00%	11.34%	10.60%	13.35%	9.03%	14.13%	8.16%
U.S. real estate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mean real return	5.63%	5.63%	6.32%	6.34%	6.39%	6.65%	6.44%	6.91%
S.D.	11.21%	11.21%	10.54%	10.59%	10.42%	10.83%	10.36%	11.05%
Sharpe ratio	0.3774	0.3774	0.4665	0.4667	0.4792	0.4847	0.4870	0.4990

Figure 1—Hedonic price indices

Panel A of Figure 1 presents the price index values for art and for the mediums oil paintings, watercolors, and drawings since 1957. Panel B of Figure 1 presents the price indices for art and for the movements Rococo, Cubism, Futurism & Constructivism, and Pop since 1982.

Panel A: Price indices for art (baseline results), oil paintings, watercolors, and drawings since 1957



Panel B: Price indices for art (baseline results), Rococo, Cubism, Futurism & Constructivism, and Pop since 1982

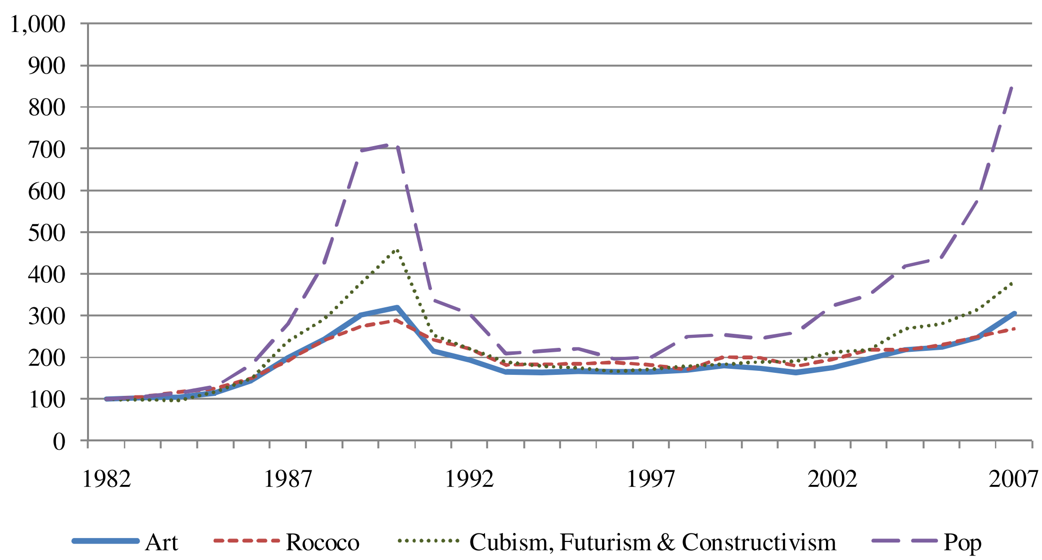
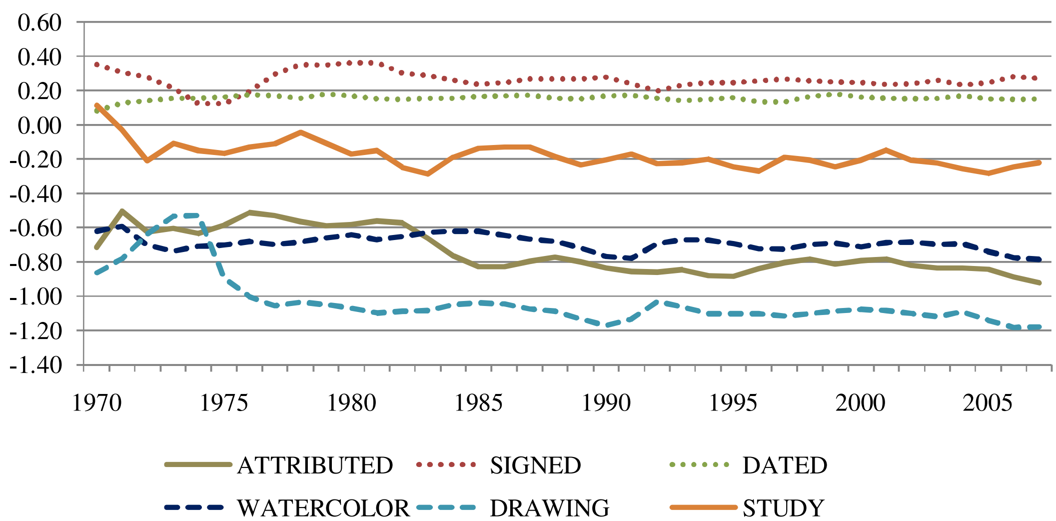


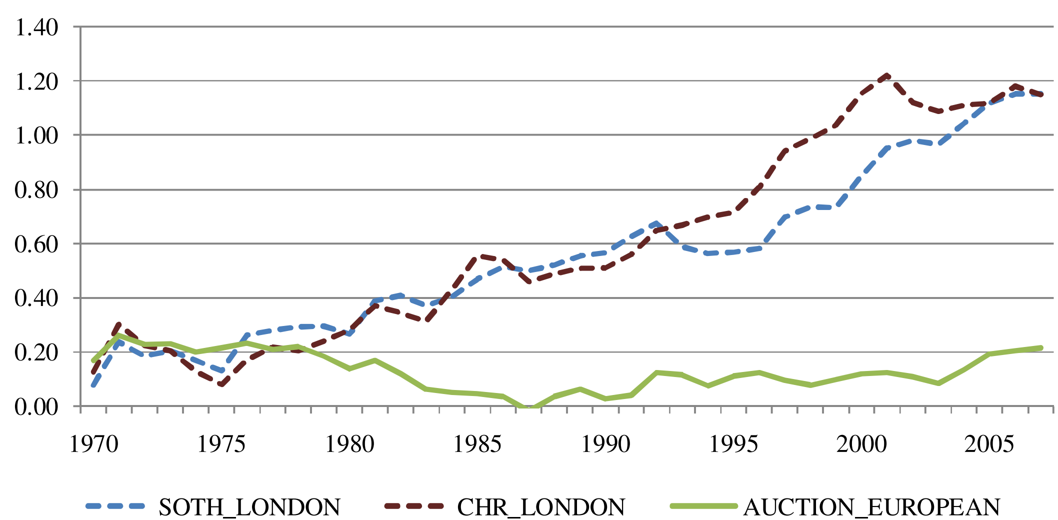
Figure 2—Adjacent year hedonic coefficients

Figure 2 presents the evolution in the hedonic coefficients in our adjacent year models since 1970. The year on the horizontal axis indicates the second of two adjoining periods. As explained in subsection 4.2, Panel A presents the results for the variables ATTRIBUTED, SIGNED, DATED, WATERCOLOR, DRAWING, and STUDY. Panel B presents the results for the variables SOTH_LONDON, CHR_LONDON, and AUCTION_EUROPEAN, as outlined in subsection 4.3.

Panel A: Coefficients on the hedonic variables ATTRIBUTED, SIGNED, DATED, WATERCOLOR, DRAWING, and STUDY in subsequent adjacent year models since 1970



Panel B: Coefficients on the hedonic variables SOTH_LONDON, CHR_LONDON, and AUCTION_EUROPEAN in subsequent adjacent year models since 1970



Chapter 3

The iconic boom in modern Russian art

Abstract: Motivated by the fast growth of personal wealth in emerging economies like Russia, we investigate the investment performance of modern Russian art. A hedonic analysis of more than 50,000 art transactions results in a geometric average return of 3.97%, in real USD terms, between 1967 and 2007. Our Russian art index shows an impressive annualized return of 12.37% since 1997. This is roughly double the average yearly appreciation of a global art market index over the same period. Especially art from the nineteenth century has performed well. The returns on Russian art correlate positively with the returns on global equities, gold, and (especially) London real estate. Also, they seem to be affected more by trends in oil prices than are global art prices. Our results illustrate how the new wealth created in fast-developing economies has its impact on the demand for art from these countries, which reflects a home bias in taste.

Over the last few years, there has been increased attention to art as a separate asset class. A couple of factors are driving this growing financial scrutiny of the investment opportunities in the art market. First, there is the maturation of the market, which now includes a variety of investment checks to attract new buyers. Second, the better availability of transaction data enables a more accurate analysis of the financial characteristics of art. The third, and most important factor, however, is the expansion of the population of high-net-worth individuals, who increasingly view art as an alternative investment (Capgemini, 2008). This evolution has also entailed the creation of art advisory services within financial institutions or as independent consultancies.

The growth in personal wealth of investors from emerging economies has recently outstripped that of individuals in more developed countries, and new collectors from China, Russia, the Middle East, and India have become important players in the art market (McAndrew, 2009). Nevertheless, virtually no academic research on the price formation of art from these countries exists. This lack of research is particularly striking given the evidence that art buyers from emerging economies have shown a passion for purchasing art of their own country in recent years (Hiraki et al., 2009). If art investors Table home bias, then one would expect to see stronger-than-average price rises in art from emerging markets since the turn of the century.

This article focuses on the returns to Russian art over a period of four decades. Driven by a boom in the prices of natural resources, the Russian economy has done very well in the last few years. Part of the corresponding new wealth has been converted into art and other "investments of passion" (Capgemini, 2008). In general, Russian collectors are nationally conscious and seem particularly interested in their own art tradition (Reviakin, 2008). McAndrew (2009) reported that Russian buyers account for more than 50% of the total sales proceeds of Russian works at the main international auction houses.[1]

We apply a hedonic pricing framework to an extensive dataset containing information on 52,154 sales of oil paintings, prints, watercolors, and drawings by 410 modern Russian artists. We find an annualized real return of 3.97% between 1967 and 2007. In the last 10 years of our sample period, the average return was much higher (12.37%), mainly thanks to very large price increases for 19th century Russian art.

This article does not aim to improve methodologically on previous research with respect to index construction. This study contributes to the literature in at least three other ways. First, it significantly deepens the understanding of the long-term historical performance of art from emerging markets. Second, in contrast to previous work, it compares price trends in an important emerging art market with those in the overall art market. Third, our results illustrate the combined impact of the home bias of art investors and a wealth creation effect in practice.

1. Related literature

There is a large and expanding literature on art auctions, price indices, and the investment performance of art. Ashenfelter and Graddy (2003) provided a general overview of the existing work. Recent empirical contributions include those by Campbell (2008) and Renneboog and Spaenjers (2010). On a theoretical level, Mandel (2009) demonstrated how a utility dividend

[1] This finding backs up more anecdotal evidence about the existence of a home bias among Russian art collectors. Reuters (2008) stated that from 2005 to 2007 "salerooms buzzed with anticipation as Russian buyers fought for precious pieces of their heritage." Likewise, *The New York Times* (Vogel, 2008) reported that between 2003 and 2007 many Russian collectors almost exclusively bought art from Russian-born artists.

derived from conspicuous art consumption may affect art returns in a consumption-based asset pricing model.

A number of issues complicate unbiased measurement of the returns on art investments. First, art is an illiquid and heterogeneous good. Most researchers have used either repeat-sales regressions or hedonic regressions to measure the price movements of art (and other infrequently traded assets) over time. Repeat-sales regressions estimate the average return of a portfolio of assets in each time period, based on purchase and sale price pairs, and hedonic regressions control for quality changes in the transacted goods by attributing implicit prices to their "utility-bearing characteristics" (Rosen, 1974). Unfortunately, each methodology has its drawbacks. While the repeat-sales technique explicitly controls for heterogeneity in attributes, the resulting dataset is often very small. Also, a sample of repeated sales may not be representative for the art market as a whole. In contrast, hedonic regressions can consider all sales on record, but control only approximately for differences in quality. Second, much art market research suffers from the lack of information on *buy-ins* (i.e., items that do not reach the reserve price at auction), in many databases. Third, art that "falls from fashion" may not be offered for sale at auction (Goetzmann, 1996). These and other issues are reviewed by Ginsburgh et al. (2006).

Ours is not the first study to undertake a country-specific analysis. For example, Agnello and Pierce (1996) investigated the investment performance of U.S. paintings; Renneboog and Van Houtte (2002) considered Belgian art; and Higgs and Worthington (2005) looked into the market for Australian art. Goodwin (2008) devoted separate chapters to a large number of countries and regions. Still, there is little academic work on emerging art markets. Mok et al. (1993) investigated the investment potential of Chinese paintings, but before 1990. The most comprehensive study so far was by Kraeussl and Logher (2008), who used the hedonic regression technique to construct price indices over different but relatively short time frames. They reported geometric annual returns of 10% between 1985 and 2008 for Russia, 5.70% between 1990 and 2008 for China, and 42.20% between 2002 and 2008 for India. The authors used their price indices to investigate the portfolio diversification benefits of investments in emerging art markets, but found limited diversification potential.

A number of previous studies have also investigated the relation between wealth creation, as proxied by equity market returns, and art prices. Renneboog and Spaenjers (2010) found a correlation of 0.47 between art and a global equity index, in contrast to the relatively low positive correlations between art and stocks reported by Mei and Moses (2002) and Pesando and Shum

(2008). Others have looked into the lagged relation between investor wealth and art prices. Chanel (1995), Worthington and Higgs (2003), and Goetzmann et al. (2011) presented evidence that equity markets impact art prices over the short run. (Goetzmann et al. also demonstrated that top incomes play a role in determining long-term art market trends.) Furthermore, Hiraki et al. (2009) showed how Japanese stock prices affected international art prices in the 1980s and 1990s. The authors claimed that their findings "may provide insight relevant to very wealthy individuals from rapidly developing economies such as those of Russia, China, or India, who have superseded Japanese investors in the international markets for art and similar luxury properties" (p. 1491). Certainly, the changing wealth patterns and the corresponding changes in demand based on the cultural and regional affinities of these new collectors may have a significant impact on changes in relative art valuation.

2. Data and methodology

We first obtain an extensive list of more than 500 Russian artists from MacDougall's Auctions, a London-based auction house that specializes in Russian art. "Russian" is typically defined very broadly in the art market. Geographically, the term includes artists or art from the whole former Soviet Republic, including countries such as Ukraine. The artists are mainly from the second half of the 19th century or from the 20th century. Important movements in modern Russian visual arts are Realism (e.g., Serov, Perov, Repin, and other members of the so-called Wanderers) and Russian avant-garde (e.g., Malevich, Kandinsky, Chagall, and Archipenko). Earlier Russian art, which is a market on its own, is not considered. Since the focus of this article is on art that can be sold through "Russian sales" at auction houses, the list also includes artists from Russian descent, and artists who were born outside of Russia but lived and worked in the country throughout their whole adult life. Based on biographical information, however, a small number of artists, whose connection with Russia appears to be very limited, are left out. We expand our database of Russian artists with about 20 artists that are included in online and offline art history resources (Renneboog and Spaenjers, 2010) in order to have as comprehensive a starting point as possible.

Second, we look up all the sales of oil paintings, prints, and works on paper (watercolors and drawings) in the Art Sales Index, an online database that contains more than three million public auction records since the middle of the previous century.[2] The Art Sales Index focuses on London sales until 1969, but it has very comprehensive worldwide coverage for the next four decades. We have data on 52,154 sales for 410 different artists. The number of sales per calendar year is listed in Panel A of Table 1. The first observation in our dataset is the May 1954 sale of a painting by Alexei Harlamoff, at Christie's London, for 260 GBP. The last available data stem from the November 2007 auctions, and include some high-profile sales by Chaim Soutine, Wassily Kandinsky, and Marc Chagall at Sotheby's New York. Although only a limited number of transactions are included for the early years of our time frame, much more observations are available starting from the end of the 1960s. Table 1 also shows that there were already many transactions prior to the late 1980s; for most of our time frame, the trend in the number of observations is very similar to that in Renneboog and Spaenjers (2010). Russian art was thus available at auction even before *glasnost*, which suggests that our art price index will not merely pick up the effects of an increased openness. The artists with the largest numbers of sales are listed in Panel B of Table 1. The most frequently sold artist in our dataset is Marc Chagall, with 6,973 observations. The most expensive transaction in our database (both in nominal and real terms) is the sale of Wassily Kandinsky's "Fugue," which was auctioned for more than 19 million USD in May 1990, at Sotheby's New York.[3]

[Insert Table 1 about here]

Third, and finally, in order to construct a price index, we use the hedonic regression methodology, which has been applied to the art market in a number of previous studies, including Buelens and Ginsburgh (1993), Chanel et al. (1996), Agnello and Pierce (1996), Czujack (1997), Lazzaro (2006), and Renneboog and Spaenjers (2010). Formally, a (semi-log) hedonic regression can be represented as follows:

$$\ln P_{kt} = \alpha + \sum_{m=1}^{M} \beta_m X_{mkt} + \sum_{t=1}^{T} \gamma_t D_{kt} + \varepsilon_{kt} \ , \qquad (1)$$

[2] The Art Sales Index is accessible at http://www.artinfo.com/artsalesindex. The prices in the Art Sales Index are hammer prices, exclusive of transaction costs, which can amount to 25% on a round trip. Historically, the Art Sales Index has not included buy-ins, which implies that we only observe prices that exceed the reserve price.

[3] The 1914 Kandinsky painting came from the Solomon R. Guggenheim's collection, just like Chagall's "Anniversaire," which was auctioned the same evening (Reif, 1990). Also included in the record-breaking sale was Renoir's "Moulin de la Galette," still the second most expensive painting of all time in real terms. Nowadays, the most expensive work of Russian art is Kazimir Malevich's "Suprematist Composition," which was sold for 53.5 million USD, excluding transaction costs, in November 2008, again at Sotheby's New York (Melikian, 2008).

where P_{kt} represents the price of good k at time t, X_{mkt} is the value of characteristic m of object k at time t, and D_{kt} is a time dummy variable that takes the value one if good k is sold in period t (and zero otherwise). The coefficients β_m reflect the attribution of a shadow price to each of the m characteristics, while the (antilogs of the) coefficients γ_t are used to construct a hedonic index. In this study, the art price index is estimated by relating the natural logs of prices in real USD to year dummies while controlling for a wide range of independent variables that capture the characteristics of the artist, of the work, and of the sale. In addition to the artist dummies capturing each artist's uniqueness, the following hedonic variables are included, mostly in line with Renneboog and Spaenjers (2010):

- *Attribution dummies*. The level of attribution may play an important role in the price formation of (older) art objects. Therefore, the dummy variables ATTRIBUTED (to), STUDIO (of), CIRCLE (of), SCHOOL (of), AFTER, and (in the) STYLE (of) are created.
- *Authenticity dummies*. SIGNED and DATED works may sell at a premium compared to works that lack visible evidence of genuineness.
- *Medium dummies*. OIL, PRINT, WATERCOLOR (including gouaches), and DRAWING differentiate between the medium categories.
- *Size*. It is well known that size matters in the pricing of art objects. In this study, the height and width in inches are represented by HEIGHT and WIDTH, respectively, with the squared values being HEIGHT^2 and WIDTH^2, respectively.
- *Topic dummies*. Following Renneboog and Spaenjers (2010), art works are categorized in different topic groups based on the first word(s) of the title: ABSTRACT, ANIMALS, LANDSCAPE, NUDE, PEOPLE, PORTRAIT, RELIGION, SELF-PORTRAIT, STILL_LIFE, UNTITLED, and URBAN. Furthermore, the dummy variable STUDY equals one if the title contains the words "study" or "etude."
- *Auction house dummies*. Especially in the higher end of the market, the art market is almost a duopoly. Therefore, for the two biggest auction houses (Sotheby's and Christie's), dummy variables for the sales in their London, New York, and other offices (e.g., SOTH_LONDON, SOTH_NY, and SOTH_OTHER) are introduced. These variables can partially proxy for the quality of the work, since Sotheby's and Christie's sell many of the best works.

- *Month dummies*. Since important auctions are often scheduled at the end of the spring or the beginning of the winter, our independent variables include dummies that indicate the month of the sale.

The descriptive statistics for these hedonic characteristics are presented in Table 2.

[Insert Table 2 about here]

3. Empirical results

The hedonic regression model outlined in Equation (1) is now estimated using ordinary least squares (OLS). One artist dummy, the year dummy 1967 (when our index will start), the medium dummy OIL, and the month dummy JUNE are left out to avoid multicollinearity. Table 3 presents the results for the hedonic variables. It shows the coefficient (with the standard deviation and the *t*-statistic), and the equivalent price impact for each variable. The latter percentage is calculated as the exponent of the coefficient, minus one.

[Insert Table 3 about here]

As expected, the coefficients on all attribution dummies are significantly negative, implying that the market values originality. For example, works from the “circle” or “school” of an artist sell for about 70% less than works by the real master. This appreciation of authenticity is also confirmed by the positive coefficients on the variables SIGNED and DATED. A signature adds about 20% to the value of a work. When an art object bears a date, its value is (on average and ceteris paribus) 10% higher than that of a non-dated object. Prints and works on paper trade at a sizeable discount compared to oil paintings; the large negative coefficient on PRINT can be explained by the fact that most prints are not unique. The results on the size variables HEIGHT and WIDTH show that the price of a piece increases with the size of the work. The fact that the squared variables are negative indicates that there are limits to the size of auctioned art. Regarding the topic dummies, we see the lowest prices for studies and UNTITLED works. In contrast, a clear premium is recorded for ABSTRACT Russian works. The coefficients on the auction house dummies show that the highest price levels for Russian art have been reached at Sotheby’s London and New York, and Christie’s London. Finally, the month dummies show that, in general, the highest prices are paid in the months May, June, November, and December, which indeed is when the most important sales traditionally take place.

Since the model also includes artist dummies, one can evaluate which artists have, in general, been the most valuable ones over the last four decades. The highest artist dummy coefficients (not reported) are found for (in decreasing order): Wassily Kandinsky, El Lissitzky, Chaim Soutine, Marc Chagall, and Kazimir Malevich. This finding is not really a surprise, given the high reputation of the artists.[4]

Taking the exponent of each time dummy coefficient (and equating the index value in 1967 to 100), the Russian art index outlined in Panel A of Table 4 is obtained. The index starts in 1967 because of the low number of observations in the years before. Also, Reviakin (2008) reported that the first Russian sales at international auction houses took place in the late 1960s. Panel B shows the annualized return per decade since 1967 and over the whole time frame. It also includes a comparison with the global art market index of Renneboog and Spaenjers (2010). Figure 1 graphically depicts the Russian and the global art price indices.

[Insert Table 4 and Figure 1 about here]

Russian art increased in value by 3.97% per year on average, in real USD terms. However, there are large differences in mean returns over time. As shown in Panel A of Table 4, Russian art greatly appreciated in value at the beginning of the 1970s, at the end of the 1980s, and between 2001 and 2007. This is broadly in line with general art market trends, as also evidenced by Figure 1.[5] While the geometric annualized returns of the Russian art market are negative for the period 1987–1997 (see Panel B of Table 4), they are significantly higher for the two surrounding decades. The high average return between 1997 and 2007 is especially remarkable: 12.37% compared to 6.30% on the global art index. Figure 1 shows that, while the two indices have generally followed the same trends, Russian art has clearly outperformed the overall art market since the start of the new century.

[4] Kandinsky, Malevich, and Lissitzky are the three artists in our dataset with the longest entries (i.e., biographies) in Oxford Art Online [http://www.oxfordartonline.com]. Chagall has the ninth highest word count of all artists in our dataset; Soutine is still in the first decile. The word-count data come from Renneboog and Spaenjers (2010).

[5] The whole art market, including the market for Russian art, has slowed somewhat after 2007, but the global public auction turnover was still higher in 2008 than in the years preceding 2007 (Artprice.com, 2009). One recent news report specifically mentioned Russian money as a factor that softened the decrease in the price level in the art market: "Super-rich Russians have been one reason for the disconnect between the financial crisis gripping the world and soaring prices for top works of art" (Collett-White, 2008).

4. Sample selection and survivorship issues

Even though we believe our list of Russian artists and the resulting dataset to be very extensive, and thus representative of the Russian art market, we perform a number of robustness checks to mitigate concerns about sample selection and survivorship issues that may have put an upward bias on our results. More specifically, we repeat the hedonic regression analysis outlined in the previous section, and rebuild our art price index, starting from a number of different subsamples of our overall dataset. First, since a large part of the list of artists considered in this study is received from an art market player, there may be a sample selection issue. Therefore, we limit the list to the artists included in Renneboog and Spaenjers (2010), who constructed their list of artists using a wide array of art history reference works. As a second check, we only consider artists who already have sales observations in the first 25 years of our dataset (1954–1978), in order to accommodate concerns about a potential "backward-filled data bias" (Mei and Moses, 2002), in the sense that we may be focusing on artists in vogue at the time of the research. Third, we limit the analysis to observations for which the artist was dead at the time of the transaction, thus eliminating the possibility that our index overstates true price trends because of the inclusion of living artists who are still building a career (a literal survivor bias). It is important to stress that all potential issues outlined here would put an upward bias on the baseline results. The average annualized real returns for these subsamples are reported in Table 5. In all cases, the returns are very close to the baseline results. This implies that we do not significantly overestimate the returns because of sample selection or survivorship issues.

[Insert Table 5 about here]

We then undertake more traditional robustness checks excluding prints (for which we only have ample data since the mid-1990s), excluding the sales of Marc Chagall (who accounts for more than 10% of our dataset, and who can also be classified as a French painter), and excluding the sales prior to 1967 (because we construct an index starting in that year). Our model is also re-estimated without the (somewhat arbitrary) topic dummies. Again, the resulting returns are very comparable to those reported in Table 4.

5. Changing tastes

It is well known that every submarket in the art market has its own dynamics. This may be especially relevant in the context of Russian art, given the profound changes in the Russian political (and cultural) system in the last two decades, and the unstable taste of Russian collectors (Vogel, 2008). Therefore, in this section, the returns on art from four different periods are compared: 1) art from the (second half of the) 19th century, the time of the unthreatened tsarist imperial Russia; 2) art created in the period 1900–1935, the years around the Russian revolution and the thriving period of the Russian avant-garde; 3) art created in the period 1936–1953, which are the last years under Stalin; and 4) art created in the period 1954–1985, which is the post-Stalin, pre-Gorbachev cold war time frame. Information on the year of creation is available for about 45% of the observations in our dataset. The returns are calculated over the whole four decades considered in this study, and over three shorter, recent time intervals: 1) 1985–1991, which are the turbulent last years of the USSR, when Gorbachev tried to reform; 2) 1991–1999, the first chaotic post-Soviet years during which Boris Yeltsin was president of the Russian federation; and 3) 1999–2007, the Putin years, in which Russia's economy (and Russian nationalism) grew impressively. The results are outlined in Table 6.

[Insert Table 6 about here]

Table 6 shows that 19th century art, which is thus art from the great Russian Empire, did remarkably poorly in the years when the USSR was dissolving (1985–1991). In the same period, art from the later Stalin years appreciated quickly. After 1991, however, Russian art from before 1900 started to outperform the other categories and, between 1999 and 2007, it even recorded an annualized real return of 23.06%. In general, it seems that a clear taste for older art has developed in recent years. This observation is in line with Reviakin (2008), who reported that members of the new Russian elite mainly buy recognizable classical and realist art.

6. Art and other assets

This section compares the returns on art to the returns on a limited number of other assets. Global Financial Data provides global indices measuring total real returns on government bonds and on equities. Return data for the dollar-denominated Russian stock market index, RTS, are available from the website of the Russian stock exchange (for the period since the mid-1990s). For reasons of comparison, we also include the returns on two other physical assets, namely, gold and London real estate. Gold prices come from Global Financial Data, while return data for London real estate, another luxury asset of interest to many affluent Russians (Freedman, 2005), are obtained from Nationwide (since year-end 1973). Mean real (dollar) returns, standard deviations, and Sharpe ratios (i.e., the returns corrected for the risk-free rate and divided by the volatility of the asset) since 1967 and 1997 are reported in Panels A and B of Table 7. Pairwise correlation coefficients can be found in Panel C.

[Insert Table 7 about here]

Over the longer time frame (Panel A), the annualized returns on the global art and Russian art indices are comparable to those on the global index for government bonds, but the volatility of both art indices is clearly higher. This translates into low Sharpe ratios, indicating that at least over the long run art investments are not competitive relative to investments in bonds or stocks. Also note that the standard deviation of the art index still underestimates the true riskiness of art investments, as explained by Renneboog and Spaenjers (2010). However, art does perform better than gold.

Panel B shows that art can do very well over shorter time frames; since 1997, art has significantly outperformed the world bond and stock indices considered here. This is thanks to a much publicized boom in the art market in the years leading up to 2007. Over this period, the Russian art index has done even better than our global art index. The Sharpe ratio points out that Russian art has been a very good investment, even considering its risk. At the same time, the return on Russian stocks was also higher than the return on the global stock index. Especially since the turn of the century, the Russian economy has thrived, and prices of Russian stocks have soared. Finally, Panel B reveals that London real estate prices have also increased dramatically between 1997 and 2007.

To shed more light on the relationship between art and the other assets under consideration, Panel C of Table 7 shows the pairwise correlation coefficients. There is a high correlation between the global art index and the Russian art index. Furthermore, we witness positive correlations between the returns on a global stock index, on the one hand, and those on art, on the other. (We do not find a significant relationship between Russian equities and art, but the number of available yearly returns for Russian stocks is very small, and the standard deviation is large.) Interestingly, we also observe a significantly positive correlation between art and the other real assets. The high correlation between art and London real estate is especially striking, and hints that these asset categories have common price-determining fundamentals.

To further examine the relationship between wealth and art prices, we follow previous research, and perform comovement regressions. The global stock index is used as an indicator of the trends in global wealth. However, also changes in world oil spot prices (since 1974) are included as an independent variable in our analysis. While other proxies for Russian buying power are conceivable (e.g. personal income), they are mostly hard to measure. Given the importance of natural resources for the Russian economy, changes in oil prices should be a reasonably good instrument for changes in Russian wealth, controlling for global economic conditions. Table 8 shows the results of our comovement regressions. Because of the relatively small number of observations available, we do not only perform a regression using the yearly returns, but also report the results of co-movement regressions that use half-yearly returns. The half-yearly art returns are calculated from the results of a hedonic regression model (not reported) that replaces the year dummies with semester dummies.

[Insert Table 8 about here]

The results in Table 8 again show that (Russian and global) art prices are strongly impacted by changes in global wealth. More relevant in our context, however, is the relationship between art and oil prices. When using yearly returns, the coefficients on the oil variable are positive but statistically insignificant. The coefficients become statistically significant (at the 10% level) in both models when considering half-yearly returns. Although the close correspondence between the global art price index and the Russian art index makes it hard to truly disentangle global from local effects, it is striking that the coefficient is almost twice as large in the set-up that tries to explain the returns on Russian art compared to the coefficient in the global art market model. The observation that changes in oil prices may matter more in the determination of Russian art prices than in setting global art prices provides further evidence of the importance of both home bias and wealth effects in the art market.

7. Conclusion

This study has looked into the price formation and returns in one of the most prominent emerging art markets. Although Russian art is gaining importance as a collecting area, no previous study has looked into its long-term investment performance. We employ a hedonic regression model, in line with Renneboog and Spaenjers (2010), to determine the annual returns. However, the results also allow us to say something about the price formation in the Russian art market. We find that premiums are paid for art works without any doubt about the attribution, for signed and dated items, for abstract art, for oil paintings, and for works auctioned by top auction houses. The most valuable art auctions are held in May and June in the first half of the year, and in November and December in the second half.

The average annual return for Russian art amounts to 3.97% (in real USD terms) over the period 1967 to 2007. Although Russian art has followed a long-term trend similar to that of the global art market, it has significantly outperformed the art market as a whole in the 2000s. We observe that art from the 19th century has done especially well since the collapse of the USSR. The finding that strong economic growth in Russia in recent years has been followed by a surge in prices for Russian art clearly hints at the existence of both home bias and a wealth creation effect in the art market. This is confirmed by co-movement regressions that evidence the role of global equity returns and changes in oil prices in determining the returns on Russian art. Overall, our results show that forecasting changes in global wealth patterns and their impact on changing the valuation of global and regional art may be an area of future research.

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Table 1—Number of observations and most frequently sold artists, 1954–2007

Panel A: Number of observations per year

Year	N	Year	N
1954	3	1981	931
1955	1	1982	802
1956	2	1983	919
1957	12	1984	785
1958	3	1985	989
1959	10	1986	888
1960	10	1987	1,338
1961	45	1988	1,604
1962	23	1989	1,927
1963	11	1990	1,551
1964	8	1991	1,029
1965	22	1992	931
1966	45	1993	1,048
1967	68	1994	1,221
1968	131	1995	1,312
1969	42	1996	1,567
1970	155	1997	1,595
1971	222	1998	1,776
1972	328	1999	1,847
1973	361	2000	1,665
1974	541	2001	1,653
1975	455	2002	1,824
1976	673	2003	1,979
1977	643	2004	3,241
1978	625	2005	4,563
1979	866	2006	4,355
1980	1,031	2007	2,478

Panel B: Artists with the largest numbers of sales

Artist	N
Marc Chagall	6,973
Andre Laskoy	2,650
Serge Poliakoff	1,797
Mane-Katz	1,698
Leopold Survage	1,422
Mstislav Dobuzhinksy	1,169
Serge Charchoune	1,151
Erte (Roman de Tirtoff)	1,104
Alexei Jawlensky	1,056
Natalia Goncharova	991

Table 2—Descriptive statistics

The attribution dummies ATTRIBUTED, STUDIO, CIRCLE, SCHOOL, AFTER, and STYLE equal one if the auction catalogue identifies the work as being "attributed to" the artist, from the "studio" of that artist, from the "circle" of the artist, from the artist's "school," "after" the artist, or "in the style of" the artist, respectively. The authenticity dummies SIGNED and DATED take the value one if the work is signed or is dated, respectively. The dummies OIL, PRINT, WATERCOLOR, and DRAWING indicate the medium. HEIGHT and WIDTH are measured in inches. The topic dummies are based on the first word(s) of the title of the work; see Renneboog and Spaenjers (2010). The auction house dummies SOTH_LONDON, SOTH_NY, SOTH_OTHER, CHR_LONDON, CHR_NY, and CHR_OTHER equal one if the sale takes place at Sotheby's London, Sotheby's New York, another branch of Sotheby's, Christie's London, Christie's New York, or another Christie's office, respectively. The month dummies indicate the month of the sale. For each variable, we report the number of observations (N). For dummy variables we also report the number of zeros and ones, and we show the mean and the standard deviation for HEIGHT and WIDTH.

	N	0	1	Mean	S.D.
Attribution dummies					
ATTRIBUTED	52,154	51,701	453		
STUDIO	52,154	52,045	109		
CIRCLE	52,154	52,121	33		
SCHOOL	52,154	52,144	10		
AFTER	52,154	51,936	218		
STYLE	52,154	52,094	60		
Authenticity dummies					
SIGNED	52,154	9,420	42,734		
DATED	52,154	34,717	17,437		
Medium dummies					
OIL	52,154	25,353	26,801		
PRINT	52,154	47,415	4,739		
WATERCOLOR	52,154	38,347	13,807		
DRAWING	52,154	45,347	6,807		
Size variables					
HEIGHT	51,520	N.A.	N.A.	19.78	11.34
WIDTH	51,515	N.A.	N.A.	19.61	12.36
Topic dummies					
STUDY	52,154	51,728	426		
ABSTRACT	52,154	47,332	4,822		
ANIMALS	52,154	51,908	246		
LANDSCAPE	52,154	50,403	1,751		
NUDE	52,154	51,691	463		
PEOPLE	52,154	49,840	2,314		
PORTRAIT	52,154	50,312	1,842		
RELIGION	52,154	51,978	176		
SELF-PORTRAIT	52,154	51,986	168		
STILL_LIFE	52,154	50,112	2,042		
UNTITLED	52,154	51,383	771		
URBAN	52,154	51,166	988		
Auction house dummies					
SOTH_LONDON	52,154	44,542	7,612		
SOTH_NY	52,154	47,595	4,559		
SOTH_OTHER	52,154	50,582	1,572		
CHR_LONDON	52,154	49,059	3,095		
CHR_NY	52,154	49,422	2,732		
CHR_OTHER	52,154	50,707	1,447		

Month dummies			
JANUARY	52,154	51,159	995
FEBRUARY	52,154	49,345	2,809
MARCH	52,154	47,308	4,846
APRIL	52,154	47,211	4,943
MAY	52,154	45,463	6,691
JUNE	52,154	43,566	8,588
JULY	52,154	50,422	1,732
AUGUST	52,154	51,921	233
SEPTEMBER	52,154	50,864	1,290
OCTOBER	52,154	47,311	4,843
NOVEMBER	52,154	43,657	8,497
DECEMBER	52,154	45,467	6,687

Table 3—Estimation results

Our model, presented in Equation (1), is estimated using OLS. The dependent variable is the natural log of the price in 2007 USD. The price impact is calculated by taking the exponent of the coefficient, and subtracting one. For the definitions of the independent variables, see Table 2.

	Coefficient	S.D.	T-statistic	Impact
Year dummies	[incl.]			
Artist dummies	[incl.]			
Attribution dummies				
ATTRIBUTED	-0.767	0.043	-17.92	-53.58%
STUDIO	-0.468	0.089	-5.28	-37.36%
CIRCLE	-1.236	0.153	-8.06	-70.96%
SCHOOL	-1.313	0.277	-4.74	-73.09%
AFTER	-0.260	0.061	-4.29	-22.89%
STYLE	-1.435	0.116	-12.35	-76.19%
Authenticity dummies				
SIGNED	0.186	0.012	15.66	20.42%
DATED	0.093	0.010	9.39	9.72%
Medium dummies				
OIL	[left out]			
PRINT	-2.859	0.021	-137.20	-94.27%
WATERCOLOR	-0.671	0.012	-54.05	-48.86%
DRAWING	-1.157	0.015	-77.74	-68.55%
Size variables				
HEIGHT	0.036	0.001	44.80	3.63%
HEIGHT^2	-1.3E-04	0.000	-23.16	-0.01%
WIDTH	0.025	0.001	31.65	2.56%
WIDTH^2	-1.0E-04	0.000	-19.54	-0.01%
Topic dummies				
STUDY	-0.179	0.044	-4.06	-16.35%
ABSTRACT	0.066	0.019	3.48	6.80%
ANIMALS	-0.139	0.057	-2.44	-12.94%
LANDSCAPE	-0.140	0.022	-6.26	-13.05%
NUDE	-0.112	0.042	-2.63	-10.58%
PEOPLE	-0.105	0.019	-5.40	-9.92%
PORTRAIT	-0.145	0.023	-6.42	-13.46%
RELIGION	-0.169	0.067	-2.52	-15.54%
SELF-PORTRAIT	0.002	0.069	0.02	0.15%
STILL_LIFE	-0.062	0.021	-2.92	-5.99%
UNTITLED	-0.205	0.034	-6.07	-18.57%
URBAN	0.004	0.029	0.12	0.36%
Auction house dummies				
SOTH_LONDON	0.567	0.013	44.08	76.32%
SOTH_NY	0.528	0.015	34.41	69.49%
SOTH_OTHER	0.382	0.024	15.99	46.58%
CHR_LONDON	0.583	0.018	33.08	79.06%
CHR_NY	0.373	0.019	19.76	45.23%
CHR_OTHER	0.051	0.024	2.13	5.28%
Month dummies				
JANUARY	-0.331	0.030	-10.98	-28.21%
FEBRUARY	-0.247	0.020	-12.52	-21.85%
MARCH	-0.162	0.016	-10.03	-14.92%
APRIL	-0.038	0.016	-2.31	-3.70%
MAY	0.037	0.015	2.46	3.75%
JUNE	[left out]			
JULY	-0.284	0.024	-11.71	-24.69%
AUGUST	-0.336	0.059	-5.72	-28.53%
SEPTEMBER	-0.304	0.027	-11.30	-26.18%
OCTOBER	-0.155	0.016	-9.47	-14.32%
NOVEMBER	0.082	0.014	5.86	8.55%
DECEMBER	-0.014	0.015	-0.96	-1.41%
Number of observations	51,514			
Adjusted R2	0.7048			
F-value	244.52			

Table 4—Index values and returns

Panel A of Table 4 presents the Russian art index. The index values are calculated by taking the exponent of the coefficients on the year dummies in the model presented in Equation (1) and estimated in Table 3. The returns are calculated by dividing the index value by the index value in the previous year and subtracting one, and are in real terms. The index value for 1967 is set equal to 100. Panel B shows the annualized real returns based on the Russian art index for each decade since 1967, and over the whole 1967–2007 time frame. It also includes the geometric average returns on the global art index constructed by Renneboog and Spaenjers (2010) for the same time periods.

Panel A: Index values of Russian art index

Year	Index	Return	Year	Index	Return
1967	100.00		1988	255.16	21.10%
1968	116.43	16.43%	1989	319.64	25.27%
1969	66.15	-43.18%	1990	382.94	19.80%
1970	91.41	38.19%	1991	218.52	-42.94%
1971	124.94	36.68%	1992	189.28	-13.38%
1972	145.72	16.63%	1993	164.71	-12.98%
1973	235.00	61.27%	1994	170.40	3.45%
1974	214.87	-8.57%	1995	163.44	-4.08%
1975	174.53	-18.77%	1996	166.65	1.96%
1976	131.68	-24.55%	1997	147.62	-11.42%
1977	109.75	-16.66%	1998	159.98	8.38%
1978	124.06	13.04%	1999	156.76	-2.01%
1979	127.63	2.87%	2000	158.55	1.14%
1980	120.01	-5.97%	2001	159.65	0.69%
1981	121.90	1.57%	2002	191.60	20.01%
1982	100.34	-17.69%	2003	224.58	17.21%
1983	96.81	-3.52%	2004	305.27	35.93%
1984	94.96	-1.92%	2005	319.33	4.61%
1985	112.65	18.63%	2006	375.82	17.69%
1986	136.85	21.48%	2007	473.75	26.06%
1987	210.70	53.96%			

Panel B: Returns on Russian art index and global art index

Sample	N	1967-1977	1977-1987	1987-1997	1997-2007	1967-2007
Russian art index (baseline results)	51,514	0.93%	6.74%	-3.50%	12.37%	3.97%
Global art index (Renneboog and Spaenjers, 2010)	1,078,482	2.57%	6.10%	-1.81%	6.30%	3.24%

Table 5—Sample selection and survivorship issues

Table 5 compares the geometric mean real returns on our Russian art index for different time frames to the returns that follow from a hedonic regression model using different subsamples of sales and using a different model in order to check the robustness of our results.

Sample	**N**	**1967-1977**	**1977-1987**	**1987-1997**	**1997-2007**	**1967-2007**
Russian art (baseline results)	*51,514*	*0.93%*	*6.74%*	*-3.50%*	*12.37%*	*3.97%*
Artists in Renneboog and Spaenjers (2010)	35,170	0.50%	7.35%	-3.54%	12.32%	3.98%
Artists with sales 1954-1978	45,462	1.00%	6.82%	-3.63%	11.99%	3.88%
Observations with artist deceased at time of sale	47,225	1.38%	6.50%	-2.99%	12.23%	4.12%
Excluding prints	46,985	1.54%	6.74%	-4.02%	13.93%	4.34%
Excluding Marc Chagall	44,738	1.71%	6.10%	-3.46%	14.13%	4.42%
Excluding sales prior to 1967	51,319	0.95%	6.74%	-3.51%	12.37%	3.97%
Excluding topic dummies from model	51,514	0.99%	6.69%	-3.53%	12.34%	3.95%

Table 6—Changing tastes

Table 6 compares the geometric mean real returns on our Russian art index for different time frames to the returns that follow from a hedonic regression model using different subsets of art, based on the creation date of the work.

Sample	**N**	**1967-2007**	**1985-1991**	**1991-1999**	**1999-2007**
Russian art (baseline results)	51,514	3.97%	11.68%	-4.07%	14.83%
Art from 1800-1899	1,913	10.98%	5.17%	9.18%	23.06%
Art from 1900-1935	9,057	5.94%	13.71%	-2.91%	17.49%
Art from 1936-1953	4,257	1.87%	17.86%	-7.44%	15.00%
Art from 1954-1985	7,984	4.15%	9.05%	-4.22%	8.31%

Table 7—Comparison with other assets

Table 7 compares the geometric mean real return and volatility of our Russian art index and the global art index of Renneboog and Spaenjers (2010) to the return and volatility of a range of other assets since 1967 (in Panel A) and since 1997 (in Panel B). The return data of the global indices for government bonds and stocks come from Global Financial Data. Russian stock market data are downloaded from the website of the Russian stock exchange [http://www.rts.ru]. Gold prices are from Global Financial Data. A price index for London real estate is downloaded from Nationwide [http://www.nationwide.co.uk] and converted to USD. Panels A and B also include ex post Sharpe ratios, using the T-bill index, from Global Financial Data, as a measure of the risk-free return. Panel C shows the pairwise correlation coefficients between our asset categories. *, **, and *** indicate significance on the 10%, 5%, and 1% level, respectively.

Panel A: Returns 1967–2007

	Russian art	Global art	Global bonds	Global stocks	Russian stocks	Gold	London real estate
Mean real return	0.0397	0.0324	0.0323	0.0572	N.A.	0.0272	N.A.
Volatility	0.2253	0.1458	0.0997	0.1720	N.A.	0.2767	N.A.
Sharpe	0.1139	0.1261	0.1914	0.2557	N.A.	0.0353	N.A.

Panel B: Returns 1997–2007

	Russian art	Global art	Global bonds	Global stocks	Russian stocks	Gold	London real estate
Mean real return	0.1237	0.0630	0.0299	0.0472	0.1331	0.0411	0.1472
Volatility	0.1245	0.0829	0.0552	0.1504	0.4441	0.1454	0.0938
Sharpe	0.7496	0.6026	0.3425	0.2495	0.2366	0.1836	1.4234

Panel C: Pairwise correlations

	Russian art	Global art	Global bonds	Global stocks	Russian stocks	Gold	London real estate
Russian art	1.0000						
Global art	0.7792***	1.0000					
Global bonds	0.0711	0.1836	1.0000				
Global stocks	0.2892*	0.4952***	0.5194***	1.0000			
Russian stocks	-0.0394	0.0783	-0.0545	-0.1045	1.0000		
Gold	0.2869*	0.3730**	-0.0141	0.1691	0.5101	1.0000	
London real estate	0.5366***	0.6616***	0.0938	0.2783	0.2352	0.4833***	1.0000

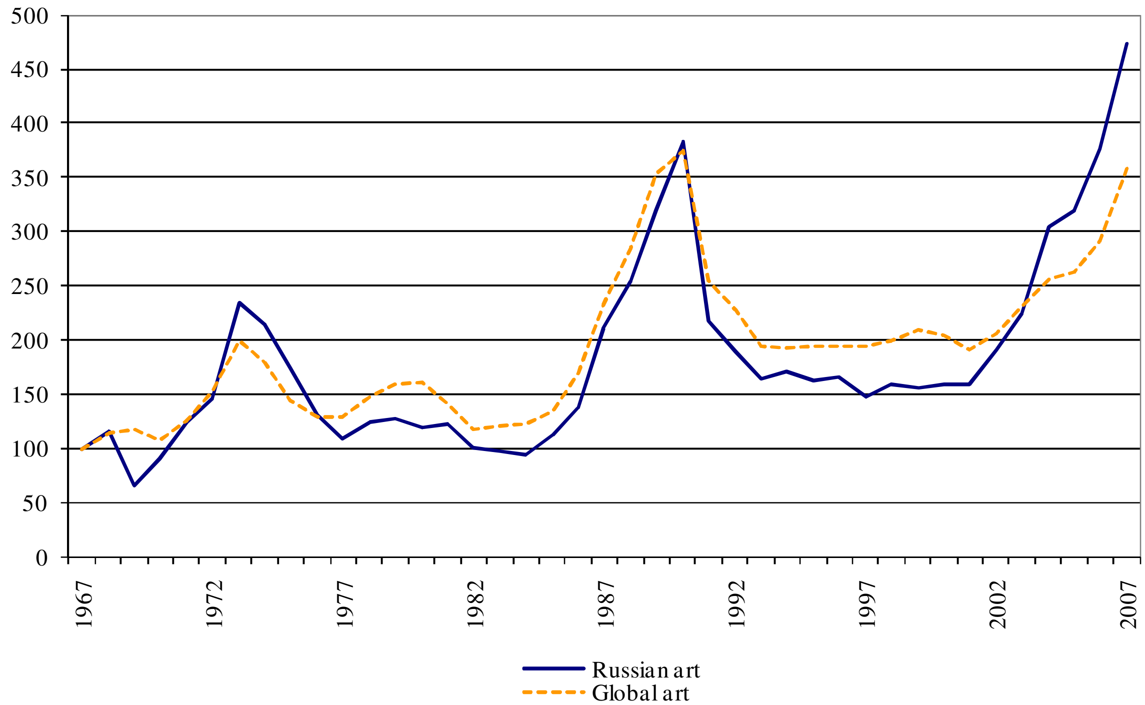
Table 8—Comovement regressions

Table 8 presents the results of comovement regressions that relate the real returns on art to the returns on world stocks and oil prices. The returns on art are from our Russian art index and the global art index of Renneboog and Spaenjers (2010). The return data for global stocks come from Global Financial Data. Oil prices (Refiner Acquisition Cost of Imported Crude Oil) are downloaded from the website of the Energy Information Administration [http://www.eia.doe.gov]. *, **, and *** indicate significance on the 10%, 5%, and 1% level, respectively.

	Yearly returns		**Halfyearly returns**	
	Russian art	**Global art**	**Russian art**	**Global art**
Global stocks	0.4754**	0.4298***	0.3103**	0.24373***
Oil	0.0844	0.0428	0.1757*	0.0916*
N	33	33	67	67
R2	0.1719	0.2420	0.0953	0.1569

Figure 1—Russian art index and global art index

Figure 1 compares the values on the Russian art index constructed in this article (see Table 4) to the values on the global art index of Renneboog and Spaenjers (2010). For both indices, the value in 1967 is set equal to 100.



Chapter 4

Art and money

Abstract: This paper investigates the impact of equity markets and top incomes on art prices. Using a newly constructed art market index, we demonstrate that equity market returns have had a significant impact on the price level in the art market over the last two centuries. We also find evidence that an increase in income inequality may lead to higher prices for art. Finally, the results of Johansen's cointegration tests strongly suggest the existence of a long-run relation between top incomes and art prices.

Unless cast in platinum and covered with diamonds, as in the case of a 2007 Damien Hirst sculpture, a work of art has little intrinsic value. Nevertheless, works of art have from time to time fetched shockingly high prices, at least from the perspective of ordinary wage earners. The highest amounts have been paid for creations of deceased artists, but also living artists—Hirst being the exemplar—have commanded multi-million dollar or pound sums for their work. It is still largely a puzzle what determines these prices, and their pattern over time.

Mandel (2009) argues that "it is the dynamic demand for art that is the only meaningful driver of investment returns". He further points out that this demand may primarily be driven by a savings motive, as in his own theoretical framework, but also by changes in income. Indeed, at auctions, the price of an art object is only limited by how much collectors are willing and able to pay for it. Higher incomes can be expected to lead to higher art consumption, and thus to a higher price level in the art market. However, given the relatively limited supply of high-quality art, average buying power may matter less to the determination of high-end art prices than how much money the wealthiest members of society can spend.[1] This is especially relevant because many high net worth individuals invest in art assets (Capgemini, 2008).

One way to measure changes in wealthy individuals' buying power, is to look at stock market returns. Equities are typically held more widely among the most affluent. A number of studies (cf. infra) have indeed looked at the relation between stock market and art market trends. In this study, we extend this work over a much longer time frame, starting our study in the first half of the nineteenth century. By doing so, we may benefit from the fact that, at least in the earlier periods of our time frame, the art market was much less globalized, enabling us to calculate a less noisy measurement of the correlation between the equity market and the art market than was previously possible. Moreover, we dissect equity returns into capital growth and dividend yield in order to establish which type of equity returns has an effect on art prices.

A complementary approach to proxying for collectors' ability to purchase art consists of studying the evolution of top incomes over time, especially if the highest incomes also go to the wealthiest individuals. We therefore empirically investigate the links between total income and its distribution on the one hand and art prices on the other, relationships which have not been analyzed before.

We utilize a repeat sales methodology that incorporates a noise reduction technique to construct an annual art price index since 1765, based on art auction transaction data from a historical resource and an online sales database. Since the initial selection of artists conforms to British taste, and nearly all the art sales considered took place in London, we relate our GBP-denominated art price index to British equity market and income series. Our results show that, over the period 1830–2007, there is a strong positive relation between equity market and art market movements. Lagged equity capital changes show significantly positive correlation with changes in art prices. The effect is robust to several alternative specifications. Next, we also find evidence of a relation between income inequality and art prices over the period 1908–2005, the time frame for which the income inequality data are available. The significance of this result is largely driven by the large variation in the British income distribution during the first half of the twentieth century. Finally, we demonstrate the existence of a robust cointegrating relationship between top incomes and art prices.

[1] The Economist (2006) puts it as follows: "Trophy asset prices may be a function of the huge dispersion of incomes. What is the point of being rich if you cannot drink the finest wines while gazing at the world's most famous artworks on the walls of your penthouse flat?"

This paper contributes to the literature in a number of respects. First, it constructs a novel annual long-run art price index, which is used to estimate the relationship between art and the stock market. The results clarify previous ambiguous evidence on the impact of equity markets on art prices, measured over shorter time windows. Second, this paper sheds light on the fundamentals of art prices; more specifically, this is the first study to investigate the interaction between income, inequality, and art prices. Third, it adds additional evidence to the growing literature on wealth effects and luxury consumption.

The remainder of this paper is structured as follows. Section 1 outlines the relevant literature on art prices, stock market wealth effects, and the market fundamentals of real assets. Section 2 presents the data for our empirical part, while Section 3 gives an overview of our results. Section 4 includes a number of robustness checks. The final section concludes.

1. Related literature

Since the first studies by Anderson (1974) and Stein (1977), an expanding literature has investigated the returns to art investments. For example, using different estimation techniques and ever-larger auction sales datasets, Baumol (1986), Pesando (1993), Buelens and Ginsburgh (1993), Goetzmann (1993), Mei and Moses (2002), Campbell (2008), Pesando and Shum (2008), and Renneboog and Spaenjers (2010) have studied the price appreciation of art over time, and compared art returns to those on financial assets. In addition, researchers have focused on a number of art market 'anomalies'.[2] We refer to Ashenfelter and Graddy (2003) and Ginsburgh et al. (2006) for more complete reviews of the literature on art auctions, prices, and price indices. In a recent contribution to the field, Mandel (2009) demonstrates how a utility dividend derived from conspicuous art consumption may affect art returns in a consumption-based asset pricing model.

There is relatively little work on the link between the art market and the broader economy, despite the anecdotal evidence that highlights the importance of the relationship. Goetzmann (1993) shows that art has a positive beta with respect to the stock market over the very long term. In contrast, however, Mei and Moses (2002) report a correlation coefficient of merely 0.04 between the S&P

[2] Anomalies (i.e. inefficiencies) that have been identified in the art market include biases in presale estimates (Mei and Moses, 2005), violations of the law of one price (Pesando, 1993), lower returns for items that have been bought in (Beggs and Graddy, 2008), and anchoring effects (Beggs and Graddy, 2009). Many authors have also investigated whether there is a "masterpiece effect", in the sense that better art makes a better investment, as first put forward by Pesando (1993), but the evidence is conflicting.

500 and their art index (annual real returns, 1950–1999). Pesando and Shum (2008) find a correlation of 0.21 between the same stock index and their index for modern prints (semi-annual real returns, 1977–2004). Some of these differences may be due to the use of different intervals of observation and estimation, or to drawbacks of the repeat-sales regression, the method commonly used to build art indices. The low correlations may also be caused by a focus on U.S. stocks, while the art market has become a global trading place over the last few decades. Indeed, Renneboog and Spaenjers (2010), using a hedonic pricing approach, report a higher positive correlation (0.47) between a global art price index and the returns on a global stock index (annual real returns, 1957–2007), than between the same art index and the S&P 500 (0.32).

Correlations may not completely capture financial market wealth effects, for different reasons. First, most art indices aggregate pricing information over a calendar year while the financial returns are normally year-to-year changes in daily (or continuously) updated indices. This leads to non-synchroneity in the measured returns. Second, it may take some time before the wealth created in financial markets finds its way to art markets. Therefore, different authors have looked at the lagged relation between investor wealth and art prices. Goetzmann (1993) finds that, at least between 1900 and 1986, art prices follow stock market trends. Also Chanel (1995) and Worthington and Higgs (2003) present evidence that stocks markets Granger-cause art prices. However, Worthington and Higgs (2004) point out that the “exact strength and persistence” of this relationship remain unclear. Moreover, the interaction between wealth and art prices over the longer run is still unclear. For example, Ginsburgh and Jeanfils (1995) find no long-term impact of stock markets on art markets. Similarly, Worthington and Higgs (2003) and Chanel (1995) conclude that it is hard to make long-run forecasts of art prices. It is important to note that, up until now, the art markets literature has typically not considered proxies for changes in investors’ buying power other than financial market movements.

While the issue of art as a financial asset has long been of interest to scholars interested in the role of art in the economy, a broader economic issue is the relationship between consumption and the behavior of asset prices (Campbell, 1999). Standard pricing models typically assume the existence of a single “representative investor”—who consumes aggregate consumption—in the economy. However, motivated by the failure of the consumption CAPM to explain the relationship between aggregate consumption and equity prices, recent research has relaxed that assumption and taken into account the concentration of financial wealth in a small cohort of investors. Poterba (2000) argues that one would expect the strongest relationship between consumption and asset prices among the households that own the majority of all stocks. As a large share of the consumption of these households typically concerns luxury goods, this would imply a solid link between stock market wealth fluctuations and luxury spending. With respect to durable luxury goods in inelastic supply, such as art and wine, Poterba (2000) notes that the concentration of stock ownership and associated wealth gains in the 1990s led to an increased demand for such goods, which in turn resulted in "significant price appreciations". Empirically, Aït-Sahalia et al. (2004) find a strong correlation between stock market returns and luxury consumption, and show that this result goes far in explaining the equity premium puzzle. Likewise, Hiraki et al. (2009) provide compelling evidence that such a "luxury consumption hypothesis" is valid in the art market. The authors use data on stock market returns, art trade flows, and art prices to show that positive wealth shocks to Japanese investors affected their art purchases in the 1980s, lifting the price level in the global art market.

Another related literature is that on the fundamentals of real estate, one of the most important classes of real assets. The studies in this field have at times related house prices to per capita income, for example to investigate whether real estate can be considered overpriced (Case and Shiller, 2003). Recently, some authors have also acknowledged the importance of the distribution of income in determining price levels. For example, Gyourko et al. (2006) demonstrate that "the thickness and length of the right tail of the income distribution" can have an important effect on real estate prices. In places that are desirable, but where little new housing is constructed, high-income families will outbid lower-income families for scarce housing, effectively driving up prices. Prices will thus rise faster when the population or income inequality increases. The authors claim that "in this sense, living in a superstar city is like owning a scarce luxury good". In a similar spirit, Van Nieuwerburgh and Weill (2010) show how the increase in house price dispersion in the United States over the last three decades can be explained by increases in the cross-sectional productivity dispersion (which directly translates into wage dispersion in their model).

2. Data

In this section, we first construct a long-run art price index based on repeated sales information extracted from Reitlinger (1961) and the Art Sales Index (subsection 2.1). Since our art market index is mainly built on London sales, and is expressed in British pounds, we also collect equity market and income data for Great Britain (subsection 2.2). Insofar as it was mostly British individuals who bought the considered artists at British auctions over our time frame, this procedure seems justified.[3] Tests for stationarity, descriptive statistics, and correlations between our variables are discussed in subsection 2.3.

2.1. Art prices

We start by building a long-term art price index. To do so, we go back to the auction sales data collected by Gerard Reitlinger in his 1961 book ‘The Economics of Taste’, which was the first book in a series of three, and investigated the history of the British paintings and drawings market. The artists whose sales are listed in Reitlinger mostly conform to English standards of taste; Guerzoni (1995) reports that Reitlinger took into account sales of the “most important and prestigious collections”. All transaction prices in Reitlinger (1961) are expressed in British pounds. Reitlinger’s data have previously been used to calculate the returns on art by, amongst others, Anderson (1974), Baumol (1986), and Goetzmann (1993). In line with these studies, we identify all repeated sales within Reitlinger’s book. (Reitlinger adds a short note, such as “see [year]” or “£[amount] in [year]”, to many transactions, which makes it possible to correctly identify repeated sales.) This gives us a dataset of 1,096 sales pairs until 1961, excluding buy-ins. We then look up all 6,661 works listed in Reitlinger’s book in the dataset constructed in Renneboog and Spaenjers (2010), which contains more than one million transactions from the online database Art Sales Index [http://www.artinfo.com/artsalesindex] since the 1920s until 2007, and try to identify resales of those same works in Great Britain. We only classify a transaction as a resale when there is a unique match of a non-ambiguous title, which occurs in 253 cases.[4] In total we thus end up with a dataset containing 1,349 repeated sales. Since the data are very sparse for the first decades covered by Reitlinger, we delete the thirteen pairs for which the purchase occurred prior to 1765. This leaves us with 1,336 repeated sales.

[3] Of course, many of the great American collections of European art had already been formed by the late 19th and early 20th centuries, and the art market became more integrated over the course of the second half of the twentieth century. If anything, this will work against finding significant results when solely utilizing British data. In Section 4, we will also include American data in our analysis as a robustness check.

[4] We classify a transaction in the Art Sales Index as a match to a sale in Reitlinger’s list if we find strong evidence of the existence of only one work with the same title by the same artist. Also, we exclude objects with attribution classifications and with very general titles (or titles that point to a much-used subject of the artist), and objects that went to museums according to Reitlinger. Additionally, where possible, we consult the provenance of the work in the online catalogue description on http://www.invaluable.com and delete a limited number of observations, for which the ownership history contradicted the original classification from our dataset.

There are some well-documented selection issues with the data. First, Reitlinger included a disproportionate high number of sales from Christie's London. However, if the sales at Christie's were representative for the higher end of the British market, this does not have to be a major problem. Second, Reitlinger also included relatively more artists that were famous in the beginning of the 1960s. The addition of transactions since the publication of the book, which affect the estimation of the whole index, should alleviate concerns about a potential upward bias. Third, in his critical review of the Reitlinger data series, Guerzoni (1995) shows that some transactions in between sales pairs seem to be missing. However, this is also the case in other repeated sales studies, and should not be expected to impact our index strongly. A more general concern is the survivorship bias in the art market. Simulating an art investment portfolio, without requiring resale, Goetzmann (1996) shows that survivorship issues can put a significant upward bias on estimated returns. However, insofar as this bias does not change significantly over time, this is not a major problem in the context of our research, since we are not focusing on calculating average long-term returns, but on identifying what determines the variation in art returns over time.

It is important to stress that, despite the caveats outlined in the previous paragraph, the Reitlinger data still constitute a unique overview of auction sales since the end of the eighteenth century. Also, the art price index is a means to an end here. Our use of the Reitlinger data and the repeat-sales methodology is a function of our intention to examine very long-term trends in income and asset market behavior. For shorter time frames, return series can be estimated more precisely, for example via a hedonic approach that uses characteristics data not available in Reitlinger (1961).

To get an estimate of the index μ over T periods based on N repeated sales observations, we follow the Bayes formulation of a repeat sales regression, which imposes some additional restrictions on the estimation, outlined in Goetzmann (1992, 1993):

$$\hat{\mu} = \left[\left(X'\Omega^{-1}X \right) + \kappa \left(I - \frac{1}{T} J \right) \right]^{-1} X'\Omega^{-1}R, \tag{1}$$

where X is a N x T matrix of dummy variables indicating the holding period for each object, the weights in Ω are the times between sales, and R is the N-dimensional vector of logged returns. Additionally, J is a matrix of ones, and κ is a constant that divides the variance of the residual error by the variance of the index:

$$\kappa = \frac{\sigma^2}{\sigma_\mu^2}. \tag{2}$$

We approximate κ by first running a simple GLS repeat sales regression on our data, which provides us with estimates of σ and σ_μ. The Bayes formulation avoids spurious negative autocorrelation in the estimated return series, and leads to a much more accurate estimator when the number of observations is relatively small (Goetzmann, 1992).

A good approximation of the annual arithmetic returns is then given by $\exp(\hat{\mu}_t + \hat{\sigma}_t^2/2)$ where the cross-sectional variance of the return can be estimated in the second stage of the Case-Shiller repeat-sales regression under the assumption that it is constant over time (Goetzmann, 1992). This specification corrects for a downward bias of the arithmetic mean that is due to the log transformation of the art prices. The return estimates can then be used to build a price index over the period of interest.

We perform the analysis outlined in the previous paragraph using our dataset of repeated sales. All prices were deflated using the U.K. RPI (Officer, 2009b) before the log transformation. (We start from real prices because the Bayes repeated sales estimator assumes that the returns conform to a prior distribution, which is more realistic in the context of real returns.) The resulting art price index, in real British pounds, is shown in Figure 1.

[Insert Figure 1 about here]

A visual inspection of the figure suggests a relationship between the real economy and art prices. For example, we see significant price drops during World War I, over the Great Depression in the 1930s, and after the oil crisis in 1973. There is no such an effect over the Second World War, when the price level was already the lowest of the whole twentieth century. Consistent with previous studies that have investigated the late twentieth century art market, we find strong price appreciations throughout the 1960s, during the art market boom at the end of the 1980s (until 1990), and in the 2000s (until 2007). In the nineteenth century, we observe strong price rises in the decades leading up to the so-called “Long Depression” that started around 1873. We will henceforward refer to the natural log of our art price index as *Art*. Our analysis will focus on the period after 1830, the first year for which all the necessary economic data are available.

2.2. Equity and income data

We build a history of British stock price returns, based on the following sources: Acheson et al. (2009) for the period 1830–1870, Grossman (2002) for the period 1870–1900, and Dimson, Marsh, and Staunton (2002, 2009) for the years thereafter. We create yearly indices covering total return, capital appreciation, and dividend yield, transformed into real terms by deflating using the U.K. RPI (Officer, 2009b). We call the natural log series *Equities*, *Equities (capital)*, and *Equities (dividends)*.

A recent literature has investigated the evolution of top incomes over the course of the twentieth century. Piketty and Saez (2006) document that the general pattern is one of a decline of top income in the inter-war period (mainly due to a decline of top capital income), and a sudden rise in top income in the Anglo-Saxon countries since the 1970s (mainly caused by a rise of top wages, i.e. executive compensation, in those countries). We use data from Atkinson and Piketty (2010)—who themselves rely on income tax data—to build a consistent series of the share of total income received by the top 0.1% of all income earners in the U.K. for the period 1908–2005.[5] This series will be referred to as *Inequality*. We refer to Atkinson (2007) for more details on data sources and methodology. However, it is important to note that the data exclude most capital gains and losses, and certain remunerations in kind. Part of the investment income will thus be captured by the equity capital appreciation variable presented before.

Atkinson (2007) observes that the time trends in the distribution of income among the employed and the distribution of personal wealth among individuals are similar. This is important in our context for two related reasons. First, it suggests that we are measuring the share of income earned by the wealthy. Second, it indicates that, by measuring (changes in) inequality in the income distribution, we also proxy for (changes in) inequality in the distribution of wealth.

We also use the data on the total personal income from Atkinson and Piketty (2010) for the years 1908–2005. The natural log of the deflated series is called *Income*. We calculate a similar series *Top income* that measures the log amount earned by the top 0.1% in every year. Yearly data on an alternative measure of total income, namely real GDP, come from Officer (2009a). The data are available from 1830 to 2007, and the logged series is labeled as *GDP*.

[5] Data on the top 0.1% income share are missing for a limited number of years. For the period 1908–1912, we estimate the share of the top 0.1% based on the coefficients of a linear regression model without intercept that relates the top 0.1% share to the top 0.05% and top 0.01% shares. The model was estimated based on the period 1913–1922. We estimate a similar model relating the top 0.1% share to the top 1% and top 0.5% shares using data from the periods 1982–1986 and 1993–1997 to get estimates of the top 0.01% for the 1987–1992 time frame. For the years 1961 and 1980 we linearly interpolated the income share based on the shares in the surrounding years.

2.3. Tests for stationarity, descriptive statistics, and correlations

As is well known, relating non-stationary series to each other would lead to spurious results. Therefore, we first want to determine whether our series are stationary or not. Table 1 shows the results of our Dickey-Fuller tests, which test for the existence of a unit root in time series. Next to the test statistics for the standard Dickey-Fuller test, we also report the results for an augmented version with one lagged difference, which accounts for potential higher-order autocorrelation. In each case, the null hypothesis is that of a unit root, or non-stationarity.

[Insert Table 1 about here]

The results in Table 1 show that we cannot reject the null hypothesis for all our original time series, implying that we cannot exclude non-stationarity. However, when considering the first differences in our time series, which measure the rate of change or indeed the return, we are able to reject non-stationarity at very high significance levels. This indicates that our series are integrated of order one; henceforward, we will thus mainly work with the first differences of the variables of interest.

Table 2 gives the descriptive statistics for these first differences. For art, we see an average annual log return of 3.20% over the period 1830–2007, with a standard deviation of almost 11%; for equities the mean is 6.51%, with a standard deviation of more than 15%. As can be expected, we find much lower volatility in the series measuring the changes in GDP and total income. The average first difference in *Inequality* is small (–0.06%), but the standard error is 0.32%, indicating some variation in this variable. We also include the regression results of an autoregressive model with two lags in Table 2, to measure autocorrelation in the first differences. One can see that several of our first-differenced variables have highly significant first-order autocorrelation in returns. We will have to take this into account in our empirical analysis.

[Insert Table 2 about here]

Table 3 gives an overview of the pairwise correlations between the different variables. The returns on art have a significantly positive correlation with the total equity returns and capital growth in equities, and with changes in GDP. We also witness a strong positive correlation between art returns and changes in income inequality, and a weaker positive correlation between the first differences in art prices and those in top income. Note that there is also a highly significant positive correlation between *Δ Equities* (and both of its components) and *Δ Inequality*, even though the latter measure does not include capital gains. This may be due to business cycle effects, for example.

[Insert Table 3 about here]

3. Empirical results

The results of our comovement analysis are outlined in subsection 3.1. First, we look at the relation between the equity market and the art market. Second, we consider the correlation between changes in income inequality and art returns. Third, we combine equity returns and changes at the top of the income distribution into a single analysis. Thereafter, we undertake a cointegration analysis in subsection 3.2, to investigate whether we can identify a long-run driver of art prices.

3.1. Comovement

The data series constructed in the previous section enable a long-term view on the relationship between art prices and equity markets. Panel A of Table 4 outlines the baseline OLS regression results. Model (1) relates our art market returns to yearly changes in our measure of income for which we have information since 1830, namely *GDP*. We thereafter include equity market returns in our analysis. However, because of potential non-synchroneity between our art price index (which aggregates information per calendar year) and equity prices (measured at year-ends), we also include the lagged first differences for both *Equities* and *Equities (capital)*. Models (2) and (3) look at overall equity returns, while models (4) and (5) differentiate between capital growth and dividend yield. We present Newey-West standard errors that account for heteroskedasticity and first-order autocorrelation in the error terms (which is signaled by (non-reported) Durbin-Watson test statistics). We also show the number of observations and *R*-squared for each regression.

[Insert Table 4 about here]

The results for the estimation of model (1) in Panel A indicate that overall income does not explain art price changes at a meaningful statistical significance level. The coefficient on *Δ GDP* is positive, but has a *p*-value of slightly more than 0.10. It is possible that the low variation in GDP changes makes it hard to identify the effect of changes in total income. Models (2) and (3) in Panel A of Table 4 show positive coefficients on both same-year and lagged equity market returns that are statistically significant. The results of model (4) and (5) show that it is mainly lagged capital gains / losses that drive art returns. The *R*-squared is around 0.13.

Up to now, we have found strong evidence that capital appreciation and depreciation drive art prices, but only very weak evidence that a proxy for overall income (GDP) is helpful in explaining art price trends. However, delving deeper into the relation between the income distribution and art prices, we report in panel B of Table 4 the results of additional regression models linking art returns to alternative proxies for both total income and income inequality. We limit our analysis to the period since 1908, the first year for which data on the income distribution are available.

As before, models (1) and (2) indicate that changes in overall income variables (such as GDP or total personal income) are not statistically significantly related to art returns. Models (3) and (4) add the first differences in *Inequality* to the regression specification, and in both cases we find positive and highly significant coefficients, indicating that art prices rise when income inequality goes up.[6] The inequality coefficient in model (4) suggests that a one percentage point increase in the share of total income earned by the top 0.1% triggers an increase in art prices of about 14 percent. Model (5) relates art price changes to the changes in *Top income*, the variable that combines information on personal income and income inequality. We observe a positive relation, but the coefficient is not significantly different from zero (*t*-statistic of 1.58). Also here this may be due to the relatively low year-to-year variation. A cointegration analysis below sheds more light on the long-run relationship between top income and art prices.

In models (1) and (2) of Panel C of Table 4, we check whether our inequality measure retains its explanatory power when controlling for same-year and lagged equity capital growth variables. We exclude the dividend variable, because dividends should already be captured by the personal income variables. We still control for total income employing the different proxies presented above. Model (3) revisits the changes in top incomes.

The results from the three models in Panel C confirm our previous findings, in that equity markets strongly affect art prices. Furthermore, although the coefficient is somewhat smaller, our income inequality measure is still a highly significant determinant of the art price level. The *R*-squared is now above 0.23, and much higher than when we looked at the impact of equities or of the income distribution separately. The results for model (3) give less support for the hypothesis that art returns can readily be associated with short-term changes in top incomes.

[6] We also re-estimated our models in Panels B and C adding the squares of *Δ Inequality*, to allow for the possibility of higher-order effects. This may be relevant since our inequality measures measure the curvature of the income distribution. However, in all cases the coefficients on *Δ Inequality* were still significantly positive and in the same order of magnitude as those reported in Table 4. In contrast, the coefficients on the quadratic terms were never statistically significant from zero at the 5% level.

We illustrate the trends in total personal income, the share held by the top 0.1%, and art prices since 1908 in Figure 2. This figure shows that art prices were lingering below the pre-World War I level until the very end of the 1960s, even though total personal income had by then increased almost fourfold. The results presented here suggest that the changes in the income distribution may have played an important role: income inequality decreased substantially in the first half of the twentieth century, eroding the relative buying power of the wealthiest.

[Insert Figure 2 about here]

3.2. Cointegration

Our previous observations provide evidence of comovement between equity markets and income inequality on the one hand and art markets on the other. However, this analysis has been concentrated on relatively short-term effects. The long-term nature of our data series and the fact that the series are integrated of order one call for further exploration of the factors that drive art prices over the long run. If it is really the wealthy, high-income individuals that determine the price level in the art market, then one would expect *Top income* (but not necessarily *GDP* or *Income*) to be cointegrated with art prices.

Panel A of Table 5 shows the results of Johansen's cointegration tests applied to our time series over the period since 1908. We report the results of the trace and maximum eigenvalue tests assuming no trend in the cointegrating equation. We include one lagged first difference in our test, which seems reasonable given that we are working with yearly data. Also, lag selection criteria, like the Akaike Information Criterion or the Schwarz Bayesian Criterion (not reported), suggest the inclusion of just one lag in most cases. Table 5 presents both the results with and without lagged equity capital growth as an exogenous variable. We find that the null hypothesis of no cointegration (between *Art* and the series in the first column) cannot be consistently rejected, except in the case of *Top income*. Over the long run, the income of the wealthy seems the key factor in the price formation in the art market.

[Insert Table 5 about here]

Panel B of Table 5 shows the resulting cointegrating equations, in which the coefficients are normalized, which is a standard procedure that allows better insight in the interaction between the variables. Setting the coefficient on *Art* equal to one, we find significantly negative coefficients on *Top income*, in line with expectations. The absolute values of these coefficients are significantly smaller than one, implying that there is no one-to-one relationship between our top incomes and art prices.

4. Robustness checks

This section includes a number of robustness checks. First, we add lagged art returns to our comovement models (subsection 4.1). Second, to test the robustness of our cointegration results, we repeat the analysis, but now adding a linear trend to the cointegrating equation (subsection 4.2). Third, we do a comovement analysis by subperiod, before and after the end of the Second World War (subsection 4.3). Fourth, and last, we check whether our baseline results still hold after adding information on the American income distribution to our analysis (subsection 4.4).

4.1. Adding lagged art returns to comovement models

We previously reported strong autocorrelation in our returns on art. There are several possible reasons for this. First, the repeat-sales regression is known to induce serial dependency, and the shrinkage estimator used to construct the index may also have this effect (Goetzmann, 1992). Second, autocorrelation may be explained by speculative dynamics also relevant in other asset markets (Cutler et al., 1991). Third, it may also partially be attributable to a 'Working effect' (Working, 1960; Schwert, 1990): our index is smoothed and will have autocorrelated returns by construction due to the implicit averaging of art prices per period. Therefore, as a first robustness check, we add the lagged art market return to some crucial comovement regressions from the previous section. The results are shown in Panel A of Table 6. Models (1), (2), and (3) repeat key regressions from Panels A, B, and C of Table 4, respectively. Durbin-Watson test statistics (not reported) indicate that the error terms no longer show significant autocorrelation, and therefore we report traditional robust (instead of Newey-West) standard errors.

[Insert Table 6 about here]

Even though the lagged art returns are highly significant in all specifications of Table 6, the coefficients of the equity related variables and their significance are largely similar to those in Table 4. Also the coefficient on *Δ Inequality* in model (2) of Table 6 is still very strongly significant. In model (3) the coefficient on the income inequality variable is positive and more than a standard deviation above zero, albeit not statistically significant (p-value of 0.14). We conclude from this analysis that including lagged art market returns somewhat weakens our results, but does not lead to different conclusions.

4.2. Adding a linear trend to cointegrating equations

In Section 3, we reported the results of a cointegration analysis that assumed no trend in the cointegrating equation. We now repeat this analysis adding such a linear trend. The results can be found in Panel B of Table 6. As before, we find statistically significant evidence of a cointegrating relationship between top incomes and art prices. The cointegrating equations (not reported) show highly significant coefficients on *Top income* of about –0.50, while the coefficients on the time trend are not statistically significant.

4.3. Analysis per subperiod

Profound changes have taken place in the art market since the middle of the previous century. Without doubt, the art market has become more globalized. One may thus expect the relation between our art price index on the one hand and the British equity market and income distribution on the other to be weaker after the Second World War. Therefore, Panel C of Table 6 repeats the same comovement analyses as before, but now differentiates between the period prior to 1945 and the post-war period.

Models (1) and (4) in Panel C show that (lagged) British equity capital growth has a statistically significant impact on our art price index for both subperiods. This is reassuring: at least for our analysis of the impact of equity markets, our results are not driven by one particular era. The other models, however, suggest that our findings on the role of income inequality in the determination of art prices are caused by trends in the first decades of the twentieth century. Indeed, the coefficient on *Δ Inequality* is significantly positive and economically large in model (2), which considers the period up to 1945, but close to zero in model (5). Models (3) and (6) combine the information on income and equities. Although for the first subperiod we do not find any statistical significance, all coefficients have the expected sign and order of magnitude. The low power probably originates from the limited number of yearly observations. The results for the second subperiod confirm the points made earlier in this paragraph: equity markets have a clear impact also after World War II, while we do not find evidence of a role for changes in the income distribution in setting art prices over the same period.

As discussed earlier, comovement analyses investigate short-term effects. The much lower variation in changes in income inequality since 1945 may make it harder to identify those effects. It may still be the case that personal income and its distribution over the population are driving art prices over the longer term. Therefore, we also repeat the cointegration analysis for the post-war period. The results are reported in Panel D of Table 6.

Panel D shows that equities and GDP cannot be identified as long-term determinants of art prices, in line with our previous findings. In contrast, we can reject the hypotheses that total personal income and top incomes (in three out of four cases) are not cointegrated with art prices. That both of these income series seem relevant since the end of World War II should not be too surprising. Art prices can be expected to move in line with overall income as long as there are no strong shocks in income inequality. Over the course of the twentieth century, the strongest shifts in income distribution occurred in the first decades.

4.4. Role of U.S. income distribution

We perform a final robustness analysis incorporating data on income and income inequality in the United States. Americans have been one of the most important groups of art collectors in the global art market over the whole twentieth century. As before, the data come from Atkinson and Piketty (2010) and are available as of 1913. *Δ Income U.S.* and *Δ Inequality U.S.* refer to the newly introduced American data. In some specifications, we also control for GBP-denominated U.S. equity capital returns, using NYSE data from Goetzmann et al. (2001) for the pre-1925 period and from CRSP for the period after. The results are shown in Panel E of Table 6. Model (1) considers the comovement of art returns with U.S. income and income inequality. Models (2) and (3) add British income and equity variables. Model (4) combines U.S. income, inequality, and equity prices. Model (5) adds all British information.

We find that there is a significant correlation between American income inequality and art returns in model (1), but that the significance of the coefficient disappears once British data are added in models (2) and (3). Something similar happens in models (4) and (5): lagged American equity capital growth is a significant factor until British variables are added to the model. That the British income inequality and lagged equity capital appreciation variables are significant factors in the determination of British art prices in models (3) and (5) show that our results are robust, and hint at some country-specificity in the relationship between economic fundamentals and art prices, even in a globalized world.

5. Conclusion

Motivated by a growing literature on stock market wealth effects and the effects of income dispersion on the prices of real assets, this article has investigated how investment and employment income—more generally, money—determines the price of art. We are able to confirm and strengthen previous evidence that equity market movements affect art prices, using a newly constructed art price index. This result is robust to many different specifications and holds even when we split the overall 1830–2007 time frame in two subperiods. We find weaker evidence for the impact of income inequality. Although there is evidence that changes in income inequality had an important effect on British art prices in the first half of the twentieth century, and that this effect is significant for the overall time frame, we do not confirm the result for the post-war period. Arguably more important, however, is that we find cointegrating relationships between top incomes and art prices, both for the total 1908–2005 period and since 1945.

Taken together, these results demonstrate that it is indeed the money of the wealthy that drives art prices. This implies that we can expect art booms whenever income inequality rises quickly. This seems exactly what we witnessed during the last period of strong art price appreciation, 2002–2007. Indeed, in many countries with large numbers of art buyers, income inequality has risen significantly in those years, mainly due to strong increases in managerial compensation. Andy Warhol, for one, would probably have applauded this evolution: "I don't think everybody should have money. It shouldn't be for everybody—you wouldn't know who was important" (Warhol, 1975).

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Table 1—Tests for stationarity

Table 1 presents the Dickey-Fuller test statistics of the original series and their first differences. *Art* is a newly constructed annual art price index based on repeated sales data from Reitlinger (1961) and the Art Sales Index. *Equities* is an index capturing total returns on British equities, based on Acheson et al. (2009), Grossman (2002), and Dimson, Marsh and Staunton (2002, 2009). *Equities (capital)* and *Equities (dividends)* cover capital appreciation and dividend yield on British equities, based on the same sources. *GDP* data come from Officer (2009a). *Income* is equal to total personal income in the U.K. *Inequality* is the share of total income earned by the top 0.1% income earners in the U.K. *Top income* is the amount of income earned by the top 0.1% income earners. Data on income and income inequality come from Atkinson and Piketty (2010). The price and income series are deflated using inflation data from Officer (2009b) and log transformed. More information on the data can be found in Section 2. In each case, we show the results of a standard Dickey-Fuller (DF) test and of an augmented Dickey-Fuller (ADF) test including one lag. For all original series, we compare with the critical values with trend. We do not assume trends for the first differences. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Period	Original series		First differences			
		DF	ADF(1)	DF		ADF(1)	
Art	1830-2007	-1.062	-1.742	-8.642	***	-7.575	***
Equities	1830-2007	-2.568	-2.727	-13.065	***	-10.030	***
Equities (capital)	1830-2007	-2.556	-2.716	-13.090	***	-10.052	***
Equities (dividends)	1830-2007	-0.173	-0.906	-6.642	***	-6.634	***
GDP	1830-2007	-1.148	-2.059	-9.294	***	-8.264	***
Income	1908-2005	-1.460	-1.557	-4.830	***	-3.982	***
Inequality	1908-2005	-1.913	-2.573	-6.089	***	-5.607	***
Top income	1908-2005	0.362	-0.141	-5.328	***	-4.063	***

Table 2—Descriptive statistics

Table 2 presents the descriptive statistics (mean, standard deviation (S.D.), minimum, and maximum) of the first differences of our variables. L1 and L2 show the coefficients and robust standard errors of an AR(2) model that relates the first differences to the lagged first differences. The variables are defined above Table 1. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Period	Mean	S.D.	Min	Max	L1		L2
Δ Art	1830-2007	0.0320	0.1077	-0.3520	0.3248	0.4197	***	-0.0515
						0.1023		0.0903
Δ Equities	1830-2007	0.0651	0.1563	-0.8189	0.6820	0.0125		-0.0838
						0.1685		0.1107
Δ Equities (capital)	1830-2007	0.0216	0.1579	-0.8948	0.6249	0.0106		-0.0851
						0.1679		0.1112
Δ Equities (dividends)	1830-2007	0.0211	0.0555	-0.1290	0.2745	0.6591	***	-0.1105
						0.1258		0.1127
Δ GDP	1830-2007	0.0196	0.0288	-0.1031	0.0947	0.3700	***	-0.0935
						0.1227		0.0864
Δ Income	1908-2005	0.0623	0.0581	-0.1415	0.2237	0.5655	***	0.0689
						0.1569		0.1299
Δ Inequality	1908-2005	-0.0006	0.0032	-0.0121	0.0099	0.2461		-0.1708
						0.1557		0.1845
Δ Top income	1908-2005	0.0547	0.0846	-0.1353	0.3451	0.4645	***	0.1081
						0.0888		0.1096

Table 3—Correlation matrix

Table 3 presents the pairwise correlations for the first differences of our variables. All correlations except those involving the first differences in *Income*, *Inequality*, and *Top income* (1908–2005) are calculated over the time frame 1830–2007. The variables are defined above Table 1. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Δ Art	Δ Eq.	Δ Eq. (cap.)	Δ Eq. (div.)	Δ GDP	Δ Inc.	Δ Ineq.	Δ Top
Δ Art	1.0000							
Δ Equities	0.1763 **	1.0000						
Δ Equities (cap.)	0.1849 **	0.9980 ***	1.0000					
Δ Equities (div.)	0.0988	0.4352 ***	0.4333 ***	1.0000				
Δ GDP	0.1670 **	0.1032	0.1136	-0.0457	1.0000			
Δ Income	-0.0157	-0.1859 *	-0.1943 *	-0.8164 ***	0.1466	1.0000		
Δ Inequality	0.3438 ***	0.3239 ***	0.3305 ***	0.3389 ***	0.1325	-0.2271 **	1.0000	
Δ Top income	0.1721 *	0.0421	0.0396	-0.3850 ***	0.1655	0.5698 ***	0.5588 ***	1.0000

Table 4—Comovement analysis

Table 4 shows the results of comovement regressions. The returns on art are regressed on a constant and a changing set of independent variables, listed in the first column. All models are estimated using ordinary least squares. Below each coefficient is the Newey-West standard error, taking into account first-order autocorrelation in the error structure. The variables are defined above Table 1. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Art and equity markets (since 1830)

	(1)		(2)		(3)		(4)		(5)	
	Δ Art		**Δ Art**		**Δ Art**		**Δ Art**		**Δ Art**	
Δ GDP	0.6258				0.2929				0.2774	
	0.3853				0.3970				0.3917	
Δ Equities			0.1189	*	0.1133	*				
			0.0641		0.0634					
Δ(-1) Equities			0.2113	***	0.1976	***				
			0.0517		0.0550					
Δ Equities (capital)							0.1252	*	0.1163	
							0.0732		0.0725	
Δ(-1) Equities (capital)							0.2114	***	0.1978	***
							0.0537		0.0574	
Δ Equities (dividends)							-0.0092		0.0116	
							0.2080		0.2052	
Number of obs.	177		176		176		176		176	
R2	0.0279		0.1248		0.1304		0.1298		0.1347	

Panel B: Art and income (since 1908)

	(1)		(2)		(3)		(4)		(5)	
	Δ Art		**Δ Art**		**Δ Art**		**Δ Art**		**Δ Art**	
Δ GDP	0.8027				0.6322					
	0.5199				0.4602					
Δ Income			-0.0344				0.1438			
			0.2849				0.2592			
Δ Inequality					12.9007	***	14.3493	***		
					3.3648		4.1834			
Δ Top income									0.2587	
									0.1635	
Number of obs.	99		97		97		97		97	
R2	0.0417		0.0002		0.1436		0.1223		0.0296	

Panel C: Art, income, and equity markets (since 1908)

	(1) **Δ Art**		(2) **Δ Art**		(3) **Δ Art**	
Δ GDP	0.3598					
	0.5036					
Δ Income			0.1998			
			0.2580			
Δ Inequality	8.7570	**	9.5855	**		
	3.8380		4.1283			
Δ Top income					0.1626	
					0.1565	
Δ Equities (capital)	0.0950		0.1086		0.1458	*
	0.0738		0.0701		0.0743	
Δ(-1) Equities (capital	0.1927	***	0.2070	***	0.2265	***
	0.0620		0.0631		0.0574	
Number of obs.	96		96		96	
R2	0.2348		0.2347		0.1962	

Table 5—Testing for cointegrating relationships

Panel A of Table 5 shows the results of Johansen's cointegration tests. In each case, the null hypothesis is that of no cointegrating relation. No trend is assumed in the cointegrating equation. The test statistics of both the trace and the maximum eigenvalue tests are reported. Panel B shows the normalized coefficients in the cointegrating relationship between art and top income. The variables are defined above Table 1. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Johansen's cointegration tests (since 1908)

	Exogenous variable							
	None				Δ(-1) Equities (cap.)			
	Trace		Max. Eigenval.		Trace		Max. Eigenval.	
Equities	5.6742		5.6616					
Equities (capital)	8.2766		8.2750					
GDP	7.2942		7.2465		7.4525		7.4044	
Income	10.1755		9.5352		8.0594		7.5196	
Top income	20.2675	***	17.8214	**	20.1233	***	18.5579	***

Panel B: Cointegrating equations

	Exogenous variable			
	None		Δ(-1) Equities (cap.)	
Art	1.0000		1.0000	
Top income	-0.4059	***	-0.4045	***
	0.0664		0.0653	

Table 6—Robustness checks

Panel A of Table 6 shows the results of comovement regressions. The returns on art are regressed on a constant and a changing set of independent variables, listed in the first column. All models are estimated using ordinary least squares. Below each coefficient is the robust standard error. Panel B shows the results of Johansen's cointegration tests. In each case, the null hypothesis is that of no cointegrating relation. A linear trend is assumed in the cointegrating equation. The test statistics of both the trace and the maximum eigenvalue tests are reported. Panel C shows the results of comovement regressions for two different subperiods (until 1945 and since 1945). The returns on art are regressed on a constant and a changing set of independent variables, listed in the first column. All models are estimated using ordinary least squares. Below each coefficient is the Newey-West standard error, taking into account first-order autocorrelation in the error structure. Panel D shows the results of Johansen's cointegration tests. In each case, the null hypothesis is that of no cointegrating relation. No linear trend is assumed in the cointegrating equation. The test statistics of both the trace and the maximum eigenvalue tests are reported. Panel E shows the results of comovement regressions. The returns on art are regressed on a constant and a changing set of independent variables, listed in the first column. All models are estimated using ordinary least squares. Below each coefficient is the Newey-West standard error, taking into account first-order autocorrelation in the error structure. The U.S. income and inequality data come from Atkinson and Piketty (2010); the U.S. equity data stem from Goetzmann et al. (2001) and CRSP. The other variables are defined above Table 1. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Comovement analysis including lagged art returns

	(1) 1830-2007 **Δ Art**		(2) 1908-2005 **Δ Art**		(3) 1908-2005 **Δ Art**	
Δ GDP	0.0692					
	0.3486					
Δ Income			0.0183		0.0895	
			0.2300		0.2369	
Δ Inequality			9.6221	**	5.7150	
			3.9087		3.8736	
Δ Equities (capital)	0.1135	**			0.1147	**
	0.0542				0.0554	
Δ(-1) Equities (capital)	0.1649	***			0.1734	***
	0.0493				0.0596	
Δ Equities (div.)	-0.0109					
	0.1612					
Δ(-1) Art	0.3438	***	0.3562	***	0.3164	**
	0.0810		0.1102		0.1073	
Number of obs.	176		96		96	
R2	0.2459		0.2347		0.3206	

Panel B: Cointegration analysis including trend in cointegrating equation

	Exogenous variable							
	None				Δ(-1) Equities (cap.)			
	Trace		Max. Eigenval.		Trace		Max. Eigenval.	
Equities	15.8616		10.5152					
Equities (capital)	16.1153		11.1468					
GDP	18.4915		11.2468		17.5318		10.7848	
Income	23.2010		17.2622	*	21.4551		16.0473	
Top income	25.6605	*	18.6019	*	26.1225	**	19.8579	**

Panel C: Comovement analysis by subperiod (before and after 1945)

	(1)		(2)		(3)	(4)		(5)	(6)	
	1830-1945		1908-1945		1908-1945	1945-2007		1945-2005	1945-2005	
	Δ Art		**Δ Art**		**Δ Art**	**Δ Art**		**Δ Art**	**Δ Art**	
Δ GDP	0.0329					0.7858				
	0.4417					1.0055				
Δ Income			0.3419		0.2478			-0.0436	0.1043	
			0.5735		0.5479			0.3772	0.3025	
Δ Inequality			21.0694	**	10.1098			1.8530	-1.5564	
			9.2915		11.5472			4.4696	5.2515	
Δ Equities (capital)	0.2870	***			0.3019	0.0266			0.0479	
	0.1378				0.2027	0.0568			0.0534	
Δ(-1) Equities (capital)	0.2078	**			0.2264	0.1513	**		0.1919	***
	0.1066				0.1524	0.0600			0.0647	
Δ Equities (div.)	-0.0866					0.0852				
	0.2695					0.4675				
Number of obs.	114		37		36	61		60	59	
R2	0.1594		0.2194		0.3392	0.1729		0.0023	0.1584	

Panel D: Cointegration analysis since 1945

	Exogenous variable							
	None				Δ(-1) Equities (cap.)			
	Trace		Max. Eigenval.		Trace		Max. Eigenval.	
Equities	3.8718		3.8180					
Equities (capital)	4.8334		4.4677					
GDP	7.4998		7.4664		7.2402		7.1566	
Income	16.1455	**	15.8426	**	14.7599	*	14.4027	**
Top income	12.8065		12.7460	*	14.0398	*	14.0333	*

Panel E: Comovement analysis including U.S. data

	(1) 1913-2007 **Δ Art**		(2) 1913-2005 **Δ Art**		(3) 1913-2005 **Δ Art**		(4) 1913-2007 **Δ Art**		(5) 1913-2005 **Δ Art**	
Δ Income U.S.	0.1764		0.1456		-0.0064		0.0049		0.0073	
	0.2001		0.1981		0.1598		0.1720		0.1580	
Δ Inequality U.S.	5.1387	*	0.8583		0.9534		2.3071		0.8736	
	2.7483		2.8745		2.5514		2.9839		2.6057	
Δ Equities (capital) U.S.							0.0825		-0.0519	
							0.0725		0.1044	
Δ(-1) Equities (capital) U.S.							0.1636	**	0.0375	
							0.0765		0.0944	
Δ Income			0.1575		0.1919				0.1828	
			0.2629		0.2750				0.3016	
Δ Inequality			13.2699	***	7.7677	*			8.3915	*
			4.2293		4.3895				4.3597	
Δ Equities (capital)					0.1137				0.1395	
					0.0716				0.0865	
Δ(-1) Equities (capital)					0.2146	***			0.1956	**
					0.0593				0.0790	
Number of obs.	94		92		91		93		91	
R2	0.0543		0.1322		0.2382		0.1174		0.2445	

Figure 1—Yearly art price index

Figure 1 shows the constructed annual art price index in real GBP for the period 1765–2007, on a logarithmic scale. The index value in 1765 is put equal to 1. The transaction data come from Reitlinger (1961) and the Art Sales Index. The index is estimated using the Bayes repeated sales methodology outlined in subsection 2.1.

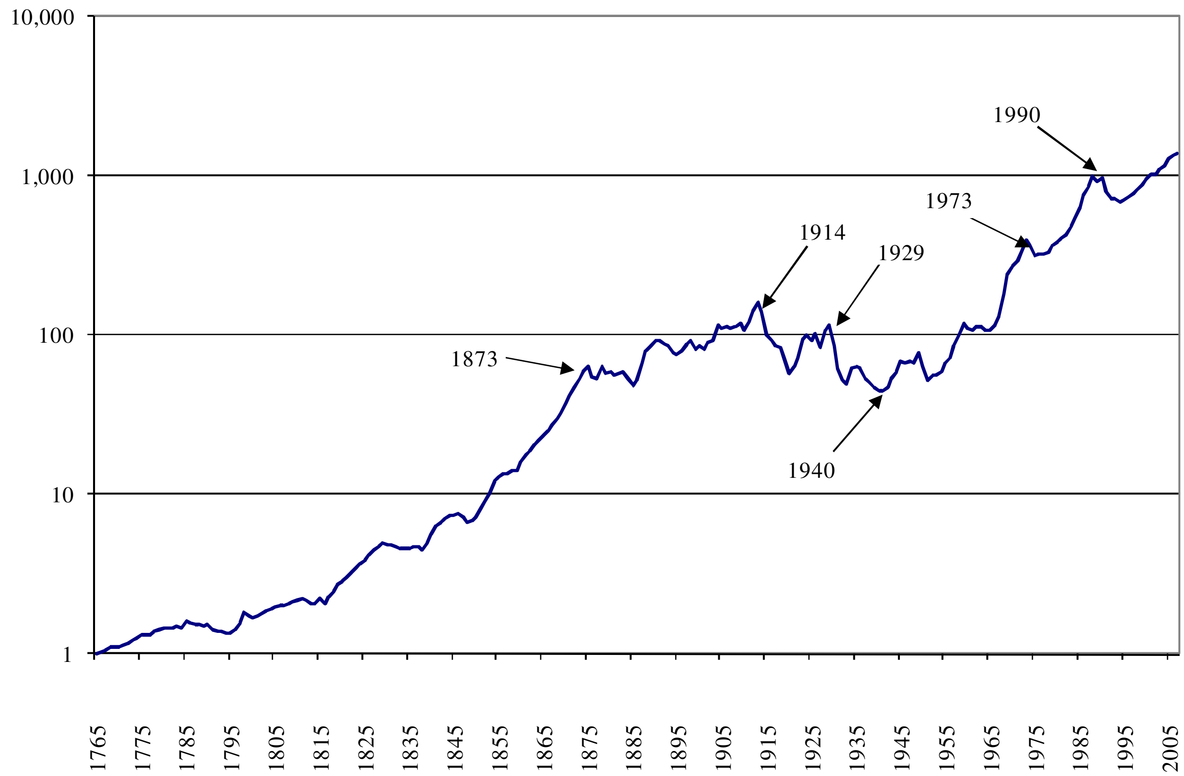
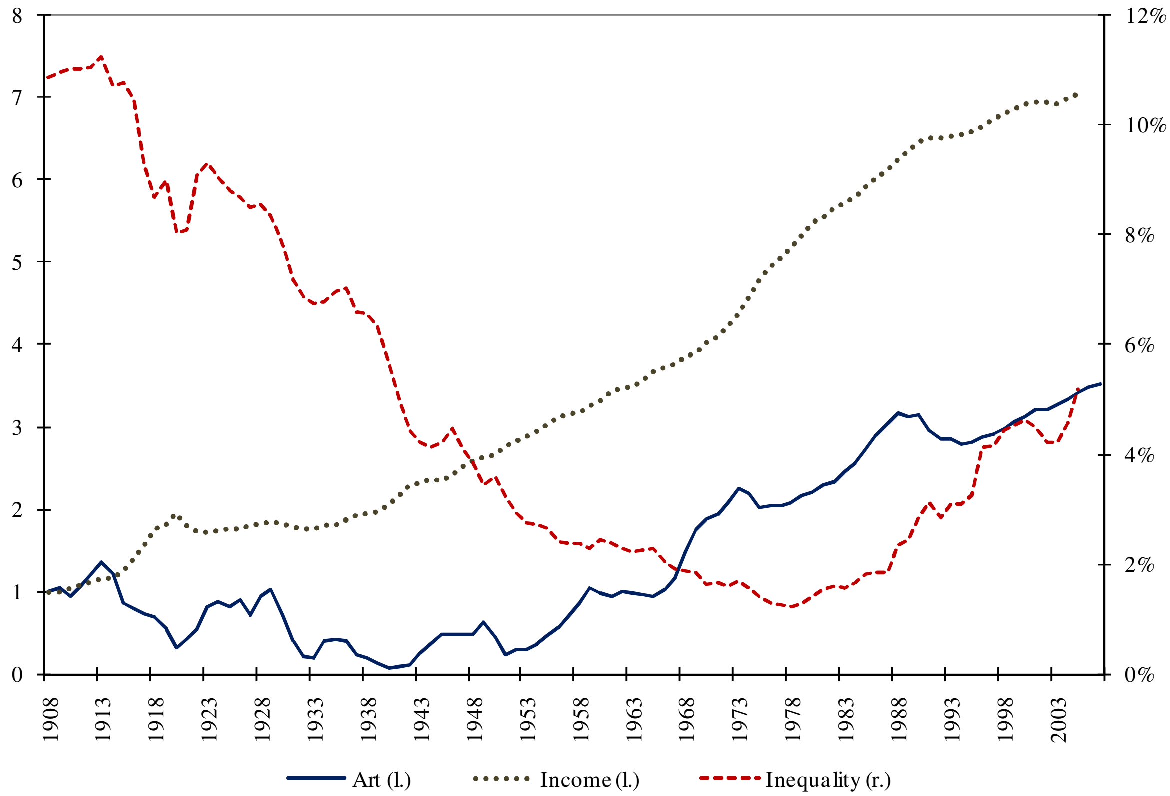


Figure 2—*Art*, *Income*, and *Inequality*

Figure 2 shows the evolution of the time series *Art*, *Income*, and *Inequality* since 1908. The variables are defined above Table 1. The values of *Art* and *Income* in 1908 are put equal to 1; these series are plotted against the left-hand side axis. In each year, the value of *Inequality* is equal to the percentage share of the top 0.1% income earners in total income; this series is read against the right-hand side axis.



Chapter 5

Returns and fundamentals in international art markets

Abstract: This paper documents that international market segmentation affects the price formation of luxury assets. Using data from more than one million auction sales, I construct art price indices spanning from the early 1970s to 2007 for 13 different countries. The variation across countries in annualized returns is substantial. I find that art prices are impacted by global economic growth and stock market trends, as well as by country-specific factors. This paper also provides international evidence that the prices of luxury goods in inelastic supply reveal information about the equity premium, in support of Aït-Sahalia et al. (2004).

Works of art are neither easily tradable across borders, nor evaluated according to globally identical standards. Yet, prior research has not investigated the impact of geographical segmentation on the price formation of art. This paper therefore has two purposes. First, I study the risks and returns in international art markets since the early 1970s. Second, I assess the relative importance of worldwide and country-specific economic fundamentals in determining art prices.

Examining the price dynamics of art is relevant, because collectible goods are gaining importance as alternative investment classes. A number of specialized funds, such as the Fine Art Fund and the Artist Rare Instrument Fund, cater to high-net-worth individuals that want to diversify their portfolios. The Wall Street Journal (2010) recently reported that almost 8% of total wealth is held in so-called "passion investments": art, musical instruments, wine, jewelry, antiques, cars, racehorses, etc. Of all luxury assets, art is the most likely to be acquired for its potential appreciation in value (Capgemini, 2010).

In general, however, non-monetary motives dominate financial considerations among buyers of art and other collectibles.[1] The performance of art as an *investment* may thus largely depend on wealthy households' demand for luxury *consumption*. Accordingly, Hiraki et al. (2009) and Goetzmann et al. (2011) show how art prices are impacted by changes in equity wealth and in top incomes.

I take an international perspective on the returns and return determinants because art markets are segmented geographically in two different but mutually reinforcing ways. First, practical and legal barriers hinder international art transactions. Most countries impose certain restrictions on the export of art, which can negatively affect foreign demand.[2] If not outlawed, international art trade may still be discouraged by import tariffs and transport costs that also induce a home bias in the consumption of other goods (Obstfeld and Rogoff, 2001). Mere distance from the sale may matter as well, since it can be hard for a potential buyer to adequately assess a work without physically inspecting it. Collectors worldwide have historically indeed been more likely to buy art close at home (Goodwin, 2008).

Second, art is a heterogeneous good, and its market is also partially segmented because of differences in taste. Most importantly, collectors generally prefer art from compatriots. In recent years, this has been particularly obvious in emerging markets such as China, India, and Russia, where the new rich are buying back their heritage (Renneboog and Spaenjers, 2011). However, survey evidence indicates that a home bias in taste is also relevant in developed economies.[3] For many artists' output, the demand will thus be the highest in their country of origin.

To study the effects of art market segmentation on the international structure of returns, I use novel data from more than one million transactions of paintings and works on paper at auctions worldwide. The data set reveals substantial differences between the 13 sample countries in the kind

[1] Surveys indicate that investment is not a motive for most collectors (Burton and Jacobsen, 1999). In a recent paper, Mandel (2010) studies the impact of shocks in GDP on international art flows, and finds that art behaves much more like a consumption good than like an investment asset.

[2] Onofri (2009) shows that export vetos negatively affect prices of Old Master paintings in Italy. The degree to which trade in cultural goods is limited by legal provisions varies across countries. Fisman and Wei (2009) analyze illicit trafficking in art and antiques.

[3] For example, 47% of the Finns interviewed by the Dia Center for the Arts (1997) indicated that they prefer Finnish art over art from other countries. Only 2% of the Dutch respondents, but 49% of the U.S. ones, chose American art over art from other regions. Schulze (1999) argues that the culture specificity of art consumption can be explained by international differences in "consumption capital" (i.e., accumulated past consumption).

of art sold. I then apply a hedonic regression model, which controls for variation in price-determining characteristics across individual sales, to the data. I find that annualized real U.S. dollar (USD) returns between the early 1970s and 2007 range from –0.90% (Belgium) to 4.60% (U.K.). The investment performance of art is clearly inferior to that of equities, despite similar return volatilities. In most countries, the annualized return on art is even below the average GDP growth rate over the same period. The average correlation in art returns between countries is comparable to that in stock returns.

The results of comovement regressions provide evidence that international art markets share considerable exposure to worldwide equity market trends and aggregate economic growth. This finding can explain why many art markets suffered after the global economic downturns in the mid-1970s and in the early 1980s, 1990s, and 2000s. Yet, art prices are also partially set locally. Augmenting the baseline model with orthogonal local factors yields an increase in explanatory power of almost 50%.

My main results are robust to a wide range of different methodologies and model specifications. For example, using repeat sales regressions (on a subsample of my data) instead of hedonic regressions, or changing the currency perspective, does not lead to different conclusions. However, I find that local fundamentals do not significantly impact the prices of works by the most highly reputable artists.

One of my key findings is that of a strong and consistent relation between stock returns and the demand for art, an important luxury consumption good. As an additional exercise, I therefore use the estimated art price indices to evaluate the equity premium, using the methodology proposed by Aït-Sahalia et al. (2004). Because of the high volatility of art returns and their substantial correlation with equity returns, art prices imply a more plausible equity premium for the U.S. than does a standard aggregate consumption measure. I also extend the procedure to an international setting, and find that art prices can partly rationalize the high equity premia observed in international data. For example, high-quality art prices imply domestic-currency equity premia of 4.25% for France and 6.25% for the U.K. over the 1971–2007 period.

This paper contributes to the literature in at least three respects. First, this is the first study to estimate long-term art returns for multiple countries, and to link variation in performance to segmentation in the modern art market.[4] Most existing research constructs a single universal art price index, often largely based on auction sales in London or New York—see, for example, Goetzmann (1993) and Mei and Moses (2002). The paper closest in spirit to this work is Ginsburgh and Jeanfils (1995), which examines long-term price comovement between three important auction locations. Also related is the evidence of violations of the law of one price provided by Pesando (1993). However, these studies do not directly investigate differences in returns and the reasons for these differences. In contrast, taking an international point of view has already furthered our understanding of the housing market. For example, Case et al. (1999), Ling and Naranjo (2002), and Bond et al. (2003) examine the international correlation of real estate returns, and the determinants of cross-country variation in investment performance.

Second, my findings significantly deepen our knowledge of the return drivers of collectibles. They point to a role for aggregate economic growth, a factor that has been largely ignored, although Schulze (1999) and Mandel (2010) find that variation in GDP correlates with international art trade. My results also highlight the importance of local fundamentals in the determination of prices of durable luxury assets.

Third, in contrast to most previous work on art investments, I explicitly acknowledge the fact that art is primarily a consumption good. Hiraki et al. (2009) adopt a similar approach, but focus solely on the cross-border effects of stock market wealth on art consumption. Relatedly, I extend the evidence of Aït-Sahalia et al. (2004) that the prices of luxury goods in inelastic supply can be used as a measure of the marginal utility of wealthy households' consumption. By examining the correlation between stock returns and art prices in an international context, this paper adds to the consumption-based asset pricing literature.

I proceed as follows. The next section describes the art transaction data and the other data series of interest. Section 2 introduces the hedonic regression model, and presents the resulting distribution of returns for each sample country. Section 3 shows the results of the comovement regressions that relate art returns to global and local fundamentals. Section 4 checks the robustness of the results to alternative specifications and methodologies. Section 5 uses art prices to explain the equity premium. Section 6 concludes and suggests avenues for further research.

[4] Historically, art market segmentation may have been even more important than it is today. For example, De Marchi (2004) shows evidence of segmentation in terms of quality, audience, and location in the London art market of the 17th century, leading to a general lack of resale possibilities.

1. Data

1.1. Art sales

I start from the database constructed in Renneboog and Spaenjers (2010). The authors first rely on different authoritative art history resources to compile an exhaustive list of 10,211 artists. They then look up all auction sales of paintings, watercolors, and drawings by these artists in the Art Sales Index, an online resource [http://www.artinfo.com/artsalesindex]. Next to prices (exclusive of transaction costs), the Art Sales Index also provides some details on the work (e.g., medium, size) and the sale (e.g., location, date) for each transaction. The final data set contains 1,088,709 observations from 1957 until 2007. As in most databases, buy-ins (i.e., items that do not reach the reserve price) are not included.

Only London sales are included until 1969, but the coverage of the data set is very broad since 1970. A majority of all sales took place outside the London or New York offices of Sotheby's and Christie's. Over the last 25 years of the studied time frame, the average number of observations per year is around 35,000. About 60% of all transactions concern oil paintings. The artist with the highest number of sales (5,405) in the data set is Pablo Picasso. In real USD terms, the most expensive transaction is `Portrait du Dr. Gachet' by Vincent van Gogh, which sold for 75 million USD in May 1990 at Christie's New York. (In nominal prices, it is `Garçon à la Pipe' by Pablo Picasso, which was auctioned off for 93 million USD in May 2004 at Sotheby's New York.) Despite the attention that goes to such high-profile sales, the average price level is much lower. The mean sales price over all observations for 2007 is 159,354 USD, while the median transaction price for the same year equals 14,775 USD.

A comparison of the total annual value of these sales to the turnover of the fine art auction market suggests that the database represents around 70% of the market in recent years. For example, a review by Artprice (2008) reports a total fine art auction turnover of 6.4 billion USD for 2006, while the total sales value for the same year in the data set used here equals 4.6 billion USD. It is important to note that art is not only sold at auction, but also privately, for example through dealers. Total turnover in the art and antiques market is roughly split equally between the two transaction types (McAndrew, 2010). However, it is generally accepted that auction prices set a benchmark also used in the private market.

I categorize all sales by country, based on the currency of the sale and the location of the auction house. For 13 different countries, I record more than 10,000 sales: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, the Netherlands, Sweden, Switzerland, the U.K., and the U.S. I focus on these countries as from now. The first columns of Table 1 show the number of observations for each sample country. Not surprisingly, most sales information is available for the U.K. (333,973 observations), and for the U.S. (216,896).

[Insert Table 1 about here]

Even in public sales, the identity and location of the buyer and the seller are typically kept secret by the auction house. Nevertheless, the data hint at a degree of segmentation in two different but related ways. First, more than 40% of all artists for whom I record at least two transactions have three quarters or more of their sales in just one country. Striking examples include Edward Hopper and Georgia O'Keeffe who account for about 200 observations each, all in the U.S. However, there are also many artists whose sales cluster outside the U.K. or the U.S. For example, 605 of the 618 sales of art by Max Ackermann took place in Germany, and 86% of the more than 2,000 transactions of Sidney Nolan works occurred in Australia.

Second, I have information on the nationality of all post-Renaissance artists classified in one or more art movements by Renneboog and Spaenjers (2010). Based on this information, about 40% of all sales in my sample can be classified as works by a Belgian, French, German, Italian, Dutch, Spanish, U.K., or U.S. artist. (These are the eight largest nationality groups in the data set. When an artist has a double nationality, I use the country of residence during his adult life.) The largest nationality subsample is that of French art (168,476 sales). Table 1 shows the distribution of sales over nationalities for each country. In Belgium, France, Germany, Italy, and the Netherlands, the number of sales of domestic works far outnumbers that of other nationalities. For example, the data set includes 68,518 sales of French works at French auction houses, but only 544 sales of British art in France. The relative importance of domestic art is substantially lower in the U.K. and the U.S., the largest art markets. Yet, Table 1 also shows that more than 80% of British and American art is sold domestically. The data thus indicate a close connection between the location of the sale and the type of art sold.

1.2. GDP growth rates and equity returns

I focus on two potentially important fundamentals of art prices for which data are widely available: GDP growth rates and equity returns. First, GDP plays an important role in determining the returns in international real estate markets (Case et al., 1999). Housing is a durable asset category that, like art, has both investment and consumption characteristics. Furthermore, both cross-country and time-series variation in economic growth have been shown to affect art imports (Schulze, 1999; Mandel, 2010). I therefore construct a series of logged and deflated USD-denominated GDP growth rates, using data from Global Financial Data. I also take a series of global GDP growth rates from the World Bank.

Second, as explained before, there is evidence of stock market wealth effects on the consumption of art. I consult Global Financial Data to collect yearly total equity returns (i.e., including dividends) for each country in my sample. As a proxy for worldwide movements in stock prices, I use the same database's capitalization-weighted World Return Index. Again, all log return series are expressed in deflated USD.

2. The returns in international art markets

To construct a (universal) price index for art, most prior research has applied either a repeat sales estimator (Pesando, 1993; Goetzmann, 1993; Mei and Moses, 2002) or a hedonic regression (Buelens and Ginsburgh, 1993; Chanel et al., 1996; Ashenfelter and Graddy, 2003; Renneboog and Spaenjers, 2009) to a data set of auction sales. Repeat sales regressions estimate returns based on purchase-and-sale price pairs of objects that trade more than once. The method provides a near-perfect control for quality, but often implies the use of small and selective data sets. In contrast, a hedonic regression can use all available sales information. It regresses transaction prices on a range of price-determining hedonic characteristics and a set of time dummies. The changes in the coefficients on the time dummies then measure returns, under the assumption that the time-invariant quality (or appeal) of each individual work is captured by the hedonic characteristics (Ashenfelter and Graddy, 2003).

My data set includes detailed information on a very large number of auction sales, but does not identify multiple transactions of the same item. I therefore use hedonic regressions to estimate a separate art price index for each country. My basic hedonic regression model is given by Equation (1):

$$\ln P_{kt} = \alpha + \sum_{m=1}^{M} \beta_m X_{mkt} + \sum_{t=1}^{T} \gamma_t D_{kt} + \varepsilon_{kt}, \tag{1}$$

where P_{kt} represents the price of good k at time t, X_{mkt} is the value of hedonic characteristic m of object k at time t, and D_{kt} is a time dummy variable which takes a value of one if good k is sold in year t (and zero otherwise). The coefficients β_m reflect the attribution of a shadow price to each of the m variables that control for variation in quality. The estimated log return in year t, r_t, is equal to $\gamma_t - \gamma_{t-1}$. (One time dummy is left out; the slope coefficient is set equal to zero for this base period.)

All auction prices are translated to deflated USD, using monthly U.S. CPI data, prior to applying the hedonic regression. In order to capture the properties of the artist, the work, and the sale, my regression model includes the following hedonic variables:

- *Textbook dummy*. To obtain an exogenous proxy for artist reputation, five different editions (1926, 1959, 1980, 1996, and 2004) of the classic art history textbook `Gardner's Art Through the Ages' were consulted. Slightly less than 10% of all considered artists are included in this resource at some point. The variable TEXTBOOK equals one if the artist features in the last edition prior to the sale.

- *Attribution dummies*. Attribution can be an important factor that influences prices, especially of older art objects. The different types of attribution used in this study—reflecting different levels of relationships between master and pupil (or follower)—are: ATTRIBUTED (to), STUDIO (of), CIRCLE (of), SCHOOL (of), AFTER, and (in the) STYLE (of).

- *Authenticity dummies*. SIGNED and DATED works may impart a premium, because there is less uncertainty about their authenticity.

- *Medium dummies*. Average price levels vary across techniques. I therefore include the variables OIL, WATERCOLOR, and DRAWING.

- *Size*. The height and width in inches are represented by HEIGHT and WIDTH, with the squared values being HEIGHT_2 and WIDTH_2.

- *Topic dummies*. Renneboog and Spaenjers (2010) create the following categories, based on the first word(s) of the title: ABSTRACT, ANIMALS, LANDSCAPE, NUDE, PEOPLE, PORTRAIT, RELIGION, SELF-PORTRAIT, STILL_LIFE, UNTITLED, and URBAN. Furthermore, the dummy STUDY equals one if the title contains either "study" or "étude".

- *Month dummies*. Important sales are often clustered in time, and therefore I include the variables JANUARY to DECEMBER.

- *Auction house dummies*. For Sotheby's and Christie's, I introduce dummy variables for their London, New York, and other sales (e.g., SOTH_LONDON, SOTH_NY, and SOTH_OTHER). For Bonhams and Phillips, two other important British auction houses, I distinguish between London and other locations. I also include two dummies that account for the sales by reputable European and American auction houses.

The descriptive statistics of these variables for the original data set are shown and discussed in Renneboog and Spaenjers (2010), but are not of key importance here. Equation (1) is estimated using ordinary least squares (OLS) for each country separately. The detailed regression output for the hedonic characteristics can be found in Appendix Table A. The results are in line with previous findings: higher prices are generally paid for works by the master himself, signed and dated items, oil paintings (relative to watercolors and drawings), larger works (up to a point), and objects sold at Sotheby's and Christie's. Studies, portraits, and untitled works on average fetch lower prices.

My main interest lies in the estimated log returns, calculated as the first differences of the coefficients on the year dummies. I exclude the time dummy coefficients for country-year combinations with less than 50 observations in order to ensure that the reported returns are representative. Also, I do not consider the pre-1971 returns for the U.K., to enable a meaningful comparison across countries. The resulting real USD annual return series for each country is presented in Appendix Table B. Table 2 shows the average return, the standard deviation, and the lowest and highest returns (with the corresponding years) over the longest available uninterrupted time frame for each country. The table also includes the average real GDP growth and equity return in those countries over the same periods.

[Insert Table 2 about here]

The annualized real USD returns on art, over the three to four decades leading up to 2007, range from –0.90% (Belgium) to 4.60% (U.K.). For the U.S., it equals 3.07%. In most cases, the average return on art is lower than the average GDP growth, and in all cases it remains below the average equity return. The bottom rows of Table 2 show that there is positive cross-sectional correlation between average art appreciation and economic growth; the coefficient of 0.52 is significant at the 0.10 level. In contrast, there is no such correlation between long-term art performance and equity returns. (Note that these correlation coefficients are calculated using 13 data points only.)

Table 2 indicates that there is cross-sectional variation in return volatility as well. However, there is no clear correlation between risk and return. The highest standard deviations are recorded for Australia (21.15%) and Sweden (20.18%). In contrast, the lowest volatility is observed in Germany (13.12%). The relatively small standard deviation for the U.S. (14.31%) may not be a surprise, given that we consider returns in USD. The reported volatilities for art are of the same order of magnitude as those of the equity markets in the sample.[5]

Despite the cross-country variation in long-term returns, art markets often display similar movements. Table 2 shows that 1991 was a bad year for international art markets: average art prices in France, Sweden, Switzerland, the U.K., and the U.S. dropped by between 29% and 61%. Many low returns were also recorded in 1981. Most art markets delivered their strongest returns either in 1972–1973 or in the second half of the 1980s.

Figure 1 presents the resulting price indices for the five largest art markets: France, Italy, the Netherlands, the U.K., and the U.S. In all cases, the log index value in 1970 is set equal to one. The plots confirm previous observations on both the cross-sectional variation in performance—over the full time frame, but also at any point in time—and the cyclical behavior of international art markets. On average, art prices increased in the early 1970s, the late 1980s, and in the last years of my sample period. Art markets suffered after 1973 and in the early 1980s, 1990s, and 2000s, which were recessionary periods in most developed economies.

[Insert Figure 1 about here]

To further investigate the comovement between the art price indices, I calculate pairwise return correlation coefficients. The results can be found in Table 3. All coefficients are significantly positive at the 0.05 level, except the correlation between Australia and Switzerland. However, also in some other cases, the correlations are remarkably low. For example, the correlations between the returns in Austria or Germany on the one hand and those in the U.S. on the other are below 0.50. In contrast, art returns in France, the U.K., and the U.S.—traditionally the countries with the largest shares of international consignors and bidders—show pairwise correlation coefficients between 0.77 and 0.87.

[Insert Table 3 about here]

[5] Due to the time aggregation of sales data, the raw standard deviations still underestimate the true riskiness of art investments. I address this problem in subsection 5.1. I report on the distributions of domestic-currency returns in subsection 5.2.

The average of the cross-country correlation coefficients in Table 3 amounts to 0.59. This exceeds the mean correlation in international property markets of about 0.40 reported by Case et al. (1999) over a shorter period. Due to the immobility of houses, real estate markets are of course defined more locally than art markets. The average correlation between international art markets is, however, almost identical to that between the international equity markets in my sample (0.58).[6]

3. The fundamentals of art prices

3.1. Global fundamentals

The previous section showed that international art markets roughly exhibit similar time series patterns. I therefore examine to which degree art price changes can be explained by global economic fundamentals. The regression equation of interest for country *i* is the following:

$$r_{it} = \alpha_i + \sum_{f=1}^{F} \beta_i^f z_{wt}^f + \varepsilon_{it}, \tag{2}$$

where r_{it} is the log return on art in time period t in country i and z^f_{wt} is *w*orld factor f in year t. The total number of fundamentals considered is equal to F. The slope coefficient β^f_i measures the sensitivity of the art market in country i to global fundamental f. The adjusted R-squared of the OLS estimation of Equation (2) for country i will be represented by $R^2_i(A)$.

As explained earlier, the fundamentals of interest are GDP growth and equity returns. In line with prior research, I use lagged equity returns, because the equity returns are calculated at the end of each year, while the art index aggregates information per calendar year (just like GDP). Moreover, there may be a lag between shocks to stock market wealth and art consumption, since most auction houses only hold sales every few months.

The results of the OLS estimations of the two-factor model presented in Equation (2) can be found in Table 4. There are between 34 and 37 annual observations since 1971 per country. The table also shows the results for the pooled data set. In this case, traditional OLS standard errors may be biased,

[6] I perform two additional analyses to examine the degree of relatedness between different art markets. First, I check whether the price indices share a common long-term trend. The results of Johansen trace tests (not reported) show no or only weak evidence of cointegration between most countries. Second, I explore whether the art markets show evidence of an increase in integration over time. I rely on two convergence measures used in Bekaert and Wang (2009): (i) the trend in the cross-sectional dispersion of returns and (ii) a time-varying beta model that relates international art returns to U.K. or U.S. returns. The results (not reported) of these tests are mixed. An empirical issue with both analyses, however, is the low number of observations for each country.

if the residuals are correlated within years. Therefore, following Petersen (2009), I cluster standard errors per year.[7]

[Insert Table 4 about here]

The results in Table 4 show that variation in worldwide economic growth impacts the price of art. For all countries in the sample, the coefficient is significantly larger than zero at the 0.10 level. I find that the sensitivity of art prices to income growth rates is higher than one for the pooled data set. This backs up previous assertions that art is a superior consumption good (Pommerehne and Feld, 1997; Mandel, 2010). Lagged global equity returns also have a substantial effect on art returns in many countries. After pooling the data, the coefficient of 0.33 is significantly higher than zero. The constant is significantly negative in nearly all cases.

The global GDP growth rates and equity returns explain between 16% and 49% of the variation in local art market returns. For the pooled data set, the adjusted *R*-squared is slightly higher than 30%. The explanatory power of these models lies in line with prior research—see, for example, Goetzmann et al. (2011). Still, there is scope for identifying other factors that play a role in art pricing. Adding local factors should simultaneously allow me to explain more of the variation in art returns, and to gauge the relative importance of global versus local fundamentals.

3.2. Adding orthogonal factors

I construct a two-step model which separates the fundamentals in common global and orthogonal local components. Case et al. (1999), Ling and Naranjo (2002), and Bond et al. (2003) follow a similar strategy to analyze the determinants of international real estate performance. First, I regress the time series of each local fundamental (e.g., growth of Australian GDP) on the global factor (e.g., growth of global GDP). More formally, for country *i* and fundamental *f*, the first stage can be expressed as follows:

$$z_{it}^{f} = \gamma_i^{f} + \delta_i^{f} z_{wt}^{f} + \zeta_{it}^{f}, \tag{3}$$

where z^f_{it} is the value of fundamental *f* in country *i* in year *t*, and z^f_{wt} is the worldwide fundamental used before. The parameter δ^f_i estimates the sensitivity of fundamental *f* in country *i* to global

[7] Another concern in any time series analysis is the possibility of serial correlation. However, Durbin-Watson statistics (not reported) do not indicate autocorrelation in the residuals. In any case, Prais-Winsten regressions that correct for first-order serial correlation yield very similar results (not reported). The results are also robust to the inclusion of country fixed effects (not reported).

changes in the same fundamental. The residuals ζ^f_{it} represent the portion of the change in each country's fundamental not explained by changes in the global fundamental. The error terms thus constitute an orthogonal, country-specific factor that can be used in a regression together with the global fundamental to explain the returns on art. Therefore, the second stage is an expanded version of Equation (2):

$$r_{it} = \alpha_i + \sum_{f=1}^{F} \beta_i^f z_{wt}^f + \sum_{f=1}^{F} \theta_i^f \zeta_{it}^f + \eta_{it}, \qquad (4)$$

where ζ^f_{it} are the residuals from Equation (3). The parameter β^f_i measures the exposure to global fundamental f for country i, while θ^f_i is an estimate of art market i's sensitivity to the orthogonal counterpart of the same fundamental. I can quantitatively evaluate the importance of the local to the global component by comparing the explanatory power of this last model to that of model (2), which did not include the orthogonal factors. If I represent the adjusted R-squared of the estimation of Equation (4) for country i by $R^2_i(B)$, then the proportional increase in explained variance, $\Delta_p R^2_i$, can be defined as:

$$\Delta_p R_i^2 \equiv \frac{[R_i^2(B) - R_i^2(A)]}{R_i^2(A)}. \qquad (5)$$

The output of the OLS estimation of Equation (4) can be found in Table 5. As before, standard errors are clustered per year on the level of the pooled data. The same table also shows the proportional increases in R-squared, as calculated in Equation (5).

[Insert Table 5 about here]

The results in Table 5 indicate a lower impact of global GDP, now that I control for the orthogonal factors. Indeed, the statistical significance disappears in many country-specific models. However, for the pooled data, the coefficient is still highly significantly positive. The orthogonal GDP factor has a significant impact for a large majority of the included countries. Some of the largest coefficients on global equities are recorded for France, the U.K., and the U.S., the most international (and most high-end) art markets. The coefficient on global equities for the pooled data is very comparable to the one in Table 4. The coefficient on the orthogonal equity factor is positive for most countries.[8] Moreover, the coefficient is significantly positive at the 0.05 level for the pooled data. In this case, the estimation clearly benefits from the large cross-section. For nearly all

[8] The coefficient is significantly negative for the U.S. This seems due to the very high correlation between the global and the U.S. equity returns. The significance disappears when using an equal-weighted or GDP-weighted average as a proxy for worldwide equity returns.

countries, the constant is no longer significantly different from zero, although it is still significantly negative for the pooled data. One economic interpretation is that, ceteris paribus, an average work of art slowly depreciates over time. The negative sign could also be related to the winner's curse in the art market, created by the private value component of art (Goetzmann and Spiegel, 1995).

The increase in R-squared varies across countries. Local deviations from global economic trends thus seem to be more important for some countries than for others. Remarkably, two of the three countries with the largest changes in explanatory power are Australia and Italy. These markets are arguably the ones most affected by distance from other countries and legal provisions, respectively.[9] The increase in R-squared is much smaller for the more internationally-oriented art markets. For Switzerland, the newly generated orthogonal variables heighten the R-squared with only 5%; for all other countries, the increase is at least 20%. Overall, local factors add about 15 percentage points to the explanatory power of the model, which is equivalent to a proportional increase of 48%. Art prices are thus, to a substantial degree, set locally.

4. Alternative specifications and methodologies

4.1. Different methods for hedonic index construction

A first methodological issue with the baseline hedonic regression model is that the coefficients on the hedonic variables—the vector β_m in Equation (1)—are constrained to be stable over time. This is a strong assumption, as aesthetic preferences may change. An *adjacent-period model* can mitigate this problem: it enables the hedonic coefficients to fluctuate, by dividing the sample in a number of subperiods (Triplett, 2004). The chain-linked price index then controls for differences in time-invariant characteristics as well as for time-varying tastes. I therefore split the sample in the periods 1970–1990 and 1990–2007, and re-estimate the hedonic model for both time frames. The first columns of Panel A of Table 6 shows that the new return estimates are similar to those in Table 2.

[Insert Table 6 about here]

Second, since the hedonic methodology aggregates sales information per calendar year, the estimated returns will suffer from spurious first-order autocorrelation and have understated standard deviations (Working, 1960). A solution is to *unsmooth* the index, a technique originated in the real

[9] Hope (2005) reports that, in Italy, many applications for export licenses are refused, even for minor works.

estate literature (Ross and Zisler, 1991), but later also applied to art (Campbell, 2008) and stamps (Dimson and Spaenjers, 2011). In line with Geltner (1993), Equation (6) expresses the uncorrected log return in period t as a weighted average of the true return in t, r^d_t, and the smoothed return in t–1:

$$r_t = (1-\alpha)r_t^d + \alpha r_{t-1}. \tag{6}$$

Equation (6) can be inverted to recover the unsmoothed return series from the observed returns:

$$r_t^d = \frac{(r_t - \alpha r_{t-1})}{(1-\alpha)}. \tag{7}$$

Working (1960) shows that aggregating prices over a year induces spurious first-order correlation in the log returns of about 0.25. I therefore use this value for α in Equation (7). The last columns of Panel A show that the volatilities are now indeed higher.

I then repeat the pooled comovement regression model from Table 5 using the newly developed art return series. Panel B of Table 6 shows the results. When using the adjacent-period model to estimate art returns, the coefficients are virtually identical to those reported earlier. In the case of the desmoothed indices, the results for the orthogonal factors are even stronger than before.

4.2. Repeat sales regressions

As explained earlier, an advantage of repeat sales regressions (RSR) is that they control for the uniqueness of each work. Although I cannot identify multiple transactions of the same item with certainty, I am able to proxy for repeat sales. I consider two items as being identical if they are from the same artist (not from a pupil or follower), have the same dimensions, carry the same title (but not "Untitled" or "Composition"), are of the same medium, and do not differ with respect to the presence of a signature or date. For the 13 sample countries, this reduces the data set from more than one million individual transactions to 32,007 "repeat sales". The distribution of these sales over the sample countries confirms the earlier claim of segmentation; for about three quarters of all transaction pairs, the "sale" took place in the same country as the "purchase".

I now apply two types of RSR to those sales pairs for which there is no change in the country of sale. First, I estimate a standard RSR model per country. In this case, all items' log returns are regressed on a matrix of dummy variables that indicates the holding periods. Second, I also run a Bayesian variation on the standard RSR, as proposed by Goetzmann (1992). The Bayes RSR imposes some additional constraints on the estimation, but avoids spurious negative autocorrelation in returns and leads to more accurate estimates when the number of observations is small.[10] The procedure may be particularly helpful in the cases of Austria, Belgium, and Denmark, for which relatively few sales pairs are identified. The new return estimates are shown in Panel A of Table 7, for the same time frames as before.

[Insert Table 7 about here]

The standard RSR return estimates exhibit high volatility for some countries. In contrast, when using the Bayes RSR, the standard deviations are somewhat lower than before. In both cases, there are substantial differences between the new average return estimates and our baseline findings. Of course, the samples are now much smaller, and most likely also include transaction pairs that are not truly repeat sales. Nevertheless, the correlations with the baseline country-year return series are around 0.60.

Repeating the comovement regressions gives the results reported in Panel B of Table 7.[11] Even though the art return series are now estimated using a completely different methodology, the results generally confirm my main findings.

4.3. Domestic-currency returns

The baseline hedonic models use dollar-denominated transaction prices. All reported art returns can thus be considered as a combination of the return in the domestic currency and the change in the exchange rate. Therefore, it is relevant to reconstruct indices in the domestic currency. All domestic-currency art prices are deflated using end-of-month CPI data from Global Financial Data prior to rerunning Equation (1).

Panel A of Table 8 shows the recalculated returns. On average, they are slightly lower than before. At 3.60%, the U.K. still has the highest average return. Of course, for the U.S., the returns are identical to those reported in Table 2. Remarkably, minimum art returns are no longer observed for

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[10] More details on the repeat sales methodologies applied here, and on alternative procedures, can be found in Goetzmann (1992).

[11] Since the standard RSR is known to induce negative serial dependancy, I add an autoregressive term to the model when using those returns as the dependent variable. As expected, the coefficient on the lagged return variable is highly significantly negative (not reported). Since the Bayes RSR may induce a smoothing of the series, I also experimented with adding a lagged term for that model, but the coefficient was not significantly above zero.

1981—a year in which the USD appreciated strongly against many currencies. I now record most lowest returns in 1975–1976 and in 1991.[12]

[Insert Table 8 about here]

The standard deviations are below those in Table 2. I decompose the overall riskiness for a dollar investor in the risk of art investments in the domestic currency on the one hand, and exchange rate risk on the other hand, as in Liu and Mei (1998). The first fraction is indicated by V_1 and is calculated as the standard deviation in the domestic currency divided by the standard deviation in USD as shown in Table 2. V_2 is then one minus V_1. In general, a large part—about three quarters or more—of the overall riskiness can be attributed to the risks of art investments, but a small part is explained by exchange rate fluctuations.

I next check whether my main conclusions hold when using domestic-currency art returns. The global GDP growth rates and equity returns in the domestic currency are split out in the same factors in USD and the log change in the inflation-adjusted exchange rate over the year. The orthogonal factors are now constructed by regressing the deflated local GDP and equity returns in the domestic currency on the global factors in USD, which still serve as common components. The results are reported in Panel B of Table 8. I find no evidence that exchange rate fluctuations significantly affect domestic-currency art returns. Although the explanatory power of the model is lower than before, the other results confirm previous findings on the impact of global and local economic growth and equity market behavior.

4.4. The importance of quality

Local factors may play a smaller role in determining the price level of art by the most highly reputable artists, which is often appreciated universally (and for which fixed transportation costs should matter less). To test this hypothesis, I split my sample into three groups, based on the length of the entry for each artist in the online encyclopedia Oxford Art Online [http://www.oxfordartonline.com]. A first subsample includes the top decile of all sales, in terms of biography word count. The other two subsamples contain the remaining above-median-quality and the below-median-quality sales. The differences in the average price level across these three groups are economically significant. In 2007, the average price in the U.S. of a piece in the top-quality

[12] I also calculate the pairwise correlation coefficients between the returns in domestic currencies (not reported). The average correlation is equal to 0.47, about one fifth lower than when using USD returns.

category was 1,453,096 USD, compared to 474,778 USD and 110,595 USD for the other two categories.

The availability of data varies over countries and over quality categories. Because no returns can be estimated for many country-category combinations during the 1970s, I report returns since 1980 in Panel A of Table 9. The results show a positive relation between quality and long-term returns: higher-quality art works appreciate in value faster. For the low-quality category, I record negative returns for four different countries.

[Insert Table 9 about here]

I now repeat the baseline comovement regression for the different subsamples, in Panel B of Table 9. I find that local deviations from global trends have no statistically significant impact on art prices for works by the most highly reputable artists. The contribution of the orthogonal factors to the explanatory power of each model is inversely related to average artist quality. Furthermore, the coefficients on the global factors are higher for higher-quality art. This larger sensitivity, especially to global stock markets, could partially explain the higher financial returns to better art in recent decades.[13]

4.5. Nationality-specific indices

Until now, I have focused on calculating returns for different countries. However, as explained earlier, because of a home bias in taste, the artist's nationality may matter in price formation as well.[14] I therefore estimate the baseline hedonic regression model for each of the eight nationality groups presented before. Panel A of Table 10 shows the distribution of the resulting returns per

[13] Since word count is measured near the end of my time frame, it is not entirely exogenous. However, most biographies were written in the early 1990s. Also, endogeneity with respect to auction prices should matter less in a peer-reviewed reference work than in more popular resources. Nevertheless, to test the robustness of the reported findings, I also split my sample based on the variable TEXTBOOK, and based on whether the sale took place at one of the two biggest auction houses or not. The results (not reported) broadly confirm the findings reported here.

[14] A number of previous studies have investigated specific national markets, such as those for American (Agnello and Pierce, 1996), Australian (Worthington and Higgs, 2006), Belgian (Renneboog and Van Houtte, 2002), and Russian (Renneboog and Spaenjers, 2011) art.

nationality over the longest possible time frames.[15] I now find somewhat less cross-sectional variation: the average real USD returns range from 3.24% (French) to 4.26% (German). This relative homogeneity could be explained by the fact that the nationality-specific samples are longer-term and not restricted to one country of sale.

[Insert Table 10 about here]

Panel B of Table 10 repeats the main comovement regression. Most results are in line with previous findings, although the impact of the orthogonal equity factor becomes close to zero. The weaker results could be due to the fact that I now consider sales worldwide. Moreover, the artists for whom I have information on their nationality are in general the better-known artists, whose prices may be determined less by local factors.

4.6. Control for income distribution

Goetzmann et al. (2011) find that increases in income inequality have historically pushed up art prices in the U.K. However, the lack of cross-sectional information in their research prevents generalization of that finding to other countries. Therefore I now add an income distribution variable as a control to my set-up. To measure income inequality, I borrow inverted Pareto coefficients from Atkinson and Piketty (2010). A higher value indicates higher concentration of income among the biggest income earners, and thus greater inequality.[16] The data are available for a majority of the sample countries, but not always on an annual basis and only until 2005. Since the inequality variable is a relative measure, I do not have to dollar-denominate or deflate. I construct a proxy for trends in global income inequality by taking a GDP-weighted average of the observed innovations in every year, based on an extended set of countries. Inequality has increased sharply in

[15] Data for all nationalities are available since 1957, although only for sales in London until 1969. As before, I delete all nationality-year pairs with less than 50 observations. Furthermore, I remove the 1963 and 1964 returns, because the Art Sales Index has non-representative coverage in 1963.

[16] The variables of Atkinson and Piketty (2010) are based on tax data. Capitals gains and losses are generally not included, although other investment income is considered. See Atkinson and Piketty (2010) for more information on data and methodology.

the late 1980s, and during the economic booms of the late 1990s and the mid-2000s. The orthogonal factor is estimated as before. Table 11 outlines the results.[17]

[Insert Table 11 about here]

Table 11 shows a significant impact of changes in global income inequality, even when controlling for GDP and equity market trends. This suggests that an increase in top incomes worldwide may indeed be associated with higher art prices. The other main conclusions on GDP and equities do not change, even though the number of observations is substantially smaller than before.

5. Art and the equity premium

Among other things, the previous sections suggest a strong relation between equity returns and the demand for art consumption. Apart from its importance for the research on collectibles, this finding is relevant from a more general asset pricing perspective. In the consumption capital asset pricing model (C-CAPM), the risk premium on an asset is determined by the covariance of its returns with consumption growth (Breeden, 1979). Typically, however, growth in aggregate consumption is too smooth and too weakly correlated with stock returns to justify the observed equity premium (Mehra and Prescott, 1985). At least since Mankiw and Zeldes (1991), one specific strand of the literature that deals with this puzzle has focused on the importance of the consumption of (actual or likely) stockholders. In particular, Aït-Sahalia et al. (2004) show that luxury consumption is more volatile and more correlated with equity returns than a standard consumption measure.

For luxury goods in fixed supply, even *prices* may reveal information about the equity premium. These prices should fluctuate proportionately with changes in demand—and thus with variation in the marginal utility of consumption. Aït-Sahalia et al. (2004) show that the equity premium implied by the prices of luxury goods in inelastic supply is given by:

$$E[R^e_{t+1}] = -\frac{Cov\,[P_t / P_{t+1}, R^e_{t+1}]}{E[P_t / P_{t+1}]}, \tag{8}$$

where R^e is the excess return on equities and P is the price level of the luxury good. The authors apply Equation (8) to two types of luxury goods, namely Manhattan pre-war apartments and fine Bordeaux wines (at U.S. auctions). The results are mixed: while the price of the most luxurious

[17] A large proportion of top incomes (e.g., bonuses, investment income) may be realized near the end of each year. Therefore, I use lagged changes in inequality. However, the results are robust to the addition of same-year inequality variables (not reported).

category of real estate covaries strongly with excess stock market returns, the correlation between the wine indices and equity returns is actually negative.

Compared to the luxury goods considered in Aït-Sahalia et al. (2004), the art price indices constructed in this paper have the advantages of being longer-term (albeit at lower frequency) and of covering a range of countries. I start by calculating the equity premium implied by U.S. art prices. Panel A of Table 12 shows the results.[18] The same panel also reports the standard deviation of the art returns, their correlation with excess equity returns, and the realized equity premium over the period of interest. Furthermore, I compare the art-implied equity premium to the premium implied by the standard C-CAPM, using National Income and Product Accounts (NIPA) consumption expenditures on non-durables and services, and assuming a relative risk aversion coefficient of 10.

[Insert Table 12 about here]

The results show that art prices are more informative about the equity premium than a traditional aggregate consumption measure. Art returns are both more volatile and more highly correlated with excess equity returns. The implied equity premium of 1.51% is still relatively small, but more than double the equity premium implied by the standard model.

In Panel B of Table 12, I calculate the implied domestic-currency equity premiums for the other countries in my sample. In many cases, the implied premium is higher than that for the U.S., because of the higher correlations between art returns and excess equity returns. For example, the implied equity premium equals 4.79% for France and 3.62% for Italy. These premia are more plausible than those typically implied by aggregate consumption measures (and reasonable risk aversion coefficients), although still below the historical equity premia.[19]

The assumption of inelastic supply is arguably more realistic in the case of top-quality art, for which fewer close substitutes exist. I therefore repeat the estimation of Equation (8) using the previously developed price indices for high-end art in France, the U.K., and the U.S. The results are

[18] As before, I use lagged equity returns. The risk-free yields are taken from Global Financial Data. I show corrected estimates of the implied equity premium that take into account time aggregation in the data by multiplying the raw implied premium by two (Breeden et al., 1989; Aït-Sahalia et al., 2004).

[19] The correlation between the implied equity premia and the realized premia across the 13 sample countries is 0.38, but not significantly different from zero. In the spirit of Jagannathan and Wang (2007), I also reconstruct art price indices based on sales information for the second half of each year only (in which sales are mainly clustered in the fourth quarter). This did not imply very different results.

shown in Panel C of Table 12. The implied equity premia of 6.25% for the U.K. and 3.86% for the U.S. are closer to the average realized equity market performance than the earlier estimates.

Figure 2 illustrates the above findings. It shows top-quality art returns, changes in NIPA consumption, and excess equity returns for the U.S. over the period 1972–2007. All series are normalized to have zero mean. Clearly, the demand for art is more volatile and more highly correlated with equity returns than is aggregate consumption.

[Insert Figure 2 about here]

6. Conclusion and discussion

This paper studies the investment performance and the price fundamentals of art from an international perspective. I apply a hedonic regression model to art sales data spanning the period between the early 1970s and 2007 for 13 different countries. Annualized art returns in real USD range from –0.90% (Belgium) to +4.60% (U.K.). The average cross-country return correlation is similar to that in international equity markets. I find strong and robust evidence that global GDP growth rates and equity returns impact art prices. However, the orthogonal local counterparts of these factors explain a substantial portion of the variation in art returns as well. This indicates that, because of segmentation, art prices are partially set locally. Furthermore, I show that art prices are more volatile and more correlated with equity prices than are standard consumption measures. They therefore also imply more plausible equity premia.

My findings are relevant for investors in art, and for all collectors who hope for financial gains. Insofar as international art markets are sensitive to global GDP and equities, an investment in art is a bet on worldwide economic growth. However, since also local fundamentals affect the prices of art works, there can be benefits to diversifying across countries (or nationalities). The results of this paper may apply to other luxury goods markets that are segmented by region (or by differences in preferences). They also reinforce the importance of the consumption of wealthy households in the pricing of assets.

At the same time, the results imply a number of possible avenues for future research. I give two examples. First, the present study has mainly examined short-term effects of GDP growth and stock market returns. Cointegration models using longer-term or higher-frequency data could probably deepen our understanding of the drivers of collectibles prices. For example, what is the impact of long-run trends in demographics? Second, the research would benefit from a better theoretical understanding of the return-generating process for collectibles, especially when investment motives become more important. The consumption-based asset pricing model of Mandel (2009), which incorporates utility from conspicuous art consumption, represents a first effort in this direction.

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Table 1—Frequency of sales per country and per nationality

Table 1 shows the total number of observations per sample country and the distribution of sales over the largest nationality groups. The last column contains the sales for which the artist's nationality is either not among those shown or unknown. All art data come from the Art Sales Index.

		Nationality of artist								
Country	**Total**	**Belgian**	**French**	**German**	**Italian**	**Dutch**	**Spanish**	**U.K.**	**U.S.**	**Other / unkn.**
Australia	29,656	22	97	16	42	59	11	165	25	29,219
Austria	15,601	879	561	673	1,165	1,525	66	91	76	10,565
Belgium	15,007	6,228	969	56	150	781	45	50	120	6,608
Canada	14,685	56	352	24	66	141	23	232	133	13,658
Denmark	22,676	431	481	166	188	909	48	53	101	20,299
France	162,996	4,004	68,518	1,472	5,282	5,766	2,759	544	2,697	71,954
Germany	63,621	1,299	3,585	18,122	1,481	3,267	291	309	1,262	34,005
Italy	49,653	757	2,140	644	18,216	967	365	259	650	25,655
Netherlands	39,651	3,203	1,246	435	391	11,939	62	64	147	22,164
Sweden	31,357	609	1,339	394	641	1,674	135	210	316	26,039
Switzerland	38,247	981	6,030	2,194	1,342	2,456	369	252	737	23,886
U.K.	333,973	13,756	44,292	7,123	22,588	24,322	5,291	32,592	4,829	179,180
U.S.	216,896	3,791	36,658	4,731	8,844	8,012	4,533	4,982	53,229	92,116

Table 2—Distribution of art returns per country

Table 2 shows a number of characteristics (average, standard deviation, minimum, and maximum) of the distribution of art returns per country, measured over the longest available time frame. The art returns are estimated using Equation (1). All art data come from the Art Sales Index. The table also includes the averages of the GDP growth rates and the equity returns over the same periods. Data on local GDP and equities come from Global Financial Data. All variables are USD-denominated, deflated, and logged. The bottom rows show the correlations of average art returns with GDP growth rates and equity returns. Coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level are indicated by *, **, and ***, respectively.

Country	Time frame	Art returns						Avg. GDP growth	Avg. equity return
		Avg.	S.D.	Min.		Max.			
Australia	1971-2007	3.09%	21.15%	-40.40%	1975	66.66%	1973	3.91%	7.56%
Austria	1971-2007	2.53%	17.44%	-38.40%	1981	37.76%	2007	4.11%	5.66%
Belgium	1975-2007	-0.90%	17.41%	-44.30%	1975	38.57%	1986	2.02%	8.42%
Canada	1972-2007	2.36%	16.12%	-27.19%	1983	28.31%	2004	3.03%	5.91%
Denmark	1976-2007	1.75%	15.56%	-41.96%	1981	29.66%	1987	2.70%	9.58%
France	1971-2007	1.14%	18.94%	-61.03%	1991	39.74%	1986	3.50%	8.00%
Germany	1971-2007	1.52%	13.12%	-28.08%	1981	25.87%	1986	1.43%	5.44%
Italy	1971-2007	1.99%	17.67%	-41.80%	1976	36.66%	1986	3.68%	6.75%
Netherlands	1971-2007	2.30%	17.94%	-44.26%	1981	48.74%	1973	4.13%	8.14%
Sweden	1971-2007	2.32%	20.18%	-55.16%	1991	44.56%	1987	2.65%	10.51%
Switzerland	1972-2007	1.99%	18.50%	-38.99%	1991	75.63%	1972	3.41%	7.30%
U.K.	1971-2007	4.60%	15.79%	-38.66%	1991	30.47%	1987	3.88%	7.94%
U.S.	1971-2007	3.07%	14.31%	-28.73%	1991	33.58%	1973	2.53%	6.19%
Cross-sectional correlation of average art returns with average GDP growth rates								0.52 *	
Cross-sectional correlation of average art returns with average equity returns									-0.14

Table 3—Pairwise correlations between art returns

Table 3 shows the pairwise correlations between the art returns of different countries. All coefficients are significantly different from zero at the 0.05 level, except the correlation between Australia and Switzerland. All returns are USD-denominated, deflated, and logged. More information on the distribution of art returns per country can be found in Table 2.

Country	Australia	Austria	Belgium	Canada	Denmark	France	Germany	Italy	Netherlands	Sweden	Switzerland	U.K.	U.S.
Australia	-												
Austria	0.49	-											
Belgium	0.41	0.68	-										
Canada	0.66	0.43	0.34	-									
Denmark	0.43	0.65	0.60	0.41	-								
France	0.55	0.69	0.66	0.53	0.70	-							
Germany	0.34	0.75	0.69	0.48	0.67	0.77	-						
Italy	0.47	0.69	0.61	0.56	0.46	0.80	0.72	-					
Netherlands	0.46	0.61	0.72	0.41	0.74	0.64	0.54	0.49	-				
Sweden	0.52	0.50	0.47	0.56	0.76	0.75	0.70	0.59	0.64	-			
Switzerland	0.27	0.47	0.49	0.52	0.59	0.73	0.66	0.55	0.40	0.64	-		
U.K.	0.69	0.67	0.65	0.64	0.78	0.87	0.60	0.67	0.63	0.68	0.67	-	
U.S.	0.71	0.46	0.50	0.64	0.60	0.77	0.39	0.55	0.56	0.64	0.54	0.84	-

Table 4—Regressions on global fundamentals

Table 4 shows the results of the OLS estimation of the regression model outlined in Equation (2), with art returns as the dependent variable, and global GDP growth rates and lagged equity returns as independent variables. The last rows of Table 4 show the results when the data for all countries are pooled. In this case, standard errors (in parentheses) are clustered by year. More information on the distribution of art returns per country can be found in Table 2. Data on world GDP are taken from the World Bank. Data on global equities come from Global Financial Data. All variables are USD-denominated, deflated, and logged. Regression coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level are indicated by *, **, and ***, respectively. The last column of Table 4 shows the adjusted *R*-squared for each model.

Country	N	α		β^{GDP}		$\beta^{Equities}$		R^2(A)
Australia	37	-0.11	**	1.41	**	0.50	***	0.28
Austria	37	-0.13	***	1.89	***	0.12		0.35
Belgium	34	-0.12	**	1.19	**	0.24		0.16
Canada	36	-0.09	**	1.22	***	0.24		0.22
Denmark	34	-0.10	**	1.52	***	0.31	*	0.34
France	37	-0.13	***	1.38	***	0.52	***	0.38
Germany	37	-0.11	***	1.56	***	0.05		0.40
Italy	37	-0.10	**	1.34	***	0.19		0.18
Netherlands	37	-0.09	*	1.12	**	0.40	**	0.24
Sweden	37	-0.12	**	1.56	***	0.40	**	0.28
Switzerland	36	-0.13	***	1.63	***	0.32	**	0.32
U.K.	37	-0.07	**	1.12	***	0.53	***	0.49
U.S.	37	-0.04		0.59	*	0.49	***	0.38
All countries	473	-0.10	***	1.35	***	0.33	**	0.31
		(0.03)		(0.23)		(0.12)		

Table 5—Regressions on global and orthogonal fundamentals

Table 5 shows the results of the OLS estimation of the regression model outlined in Equation (4), with art returns as the dependent variable, and global and orthogonal GDP growth rates and lagged equity returns as independent variables. The orthogonal factors are the residuals from the OLS estimation of Equation (3), which regresses the time series of each local factor on that of the global fundamental for each country. The bottom rows of Table 5 show the results when the data for all countries are pooled. In this case, standard errors (in parentheses) are clustered by year. More information on the distribution of art returns per country can be found in Table 2. Data on world GDP are taken from the World Bank. Data on local GDP and on global and local equities come from Global Financial Data. All variables are USD-denominated, deflated, and logged. Regression coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level are indicated by *, **, and ***, respectively. The last columns of Table 5 show the adjusted *R*-squared and the proportional increase in explanatory power relative to the models in Table 4.

Country	N	α	Global		Orthogonal		R^2(B)	$\Delta_P R^2$
			β^{GDP}	$\beta^{Equities}$	θ^{GDP}	$\theta^{Equities}$		
Australia	37	-0.04	0.34	0.47 ***	1.04 ***	0.12	0.50	0.77
Austria	37	0.00	0.07	0.16	0.99 ***	0.12	0.55	0.60
Belgium	34	0.00	-0.28	0.23	0.70 *	0.31	0.36	1.28
Canada	36	-0.05	0.78 *	0.21	0.86 **	0.24	0.31	0.42
Denmark	34	-0.06	0.78 *	0.32 **	0.63 ***	0.07	0.51	0.47
France	37	-0.06	0.43	0.54 ***	0.71 ***	0.08	0.51	0.37
Germany	37	-0.06 **	1.03 ***	0.04	0.48 ***	0.03	0.55	0.38
Italy	37	-0.04	0.51	0.18	0.68 ***	0.16	0.39	1.24
Netherlands	37	-0.04	0.44	0.39 ***	0.60 ***	0.13	0.38	0.54
Sweden	37	-0.07	0.79	0.36 **	0.68 ***	0.27	0.43	0.52
Switzerland	36	-0.10 *	1.19 **	0.30 *	0.37	-0.02	0.34	0.05
U.K.	37	-0.05	0.68 *	0.52 ***	0.48 ***	0.07	0.59	0.20
U.S.	37	-0.01	0.08	0.46 ***	0.99	-0.73 **	0.48	0.27
All countries	473	-0.05 **	0.64 ***	0.32 ***	0.62 ***	0.13 **	0.46	0.48
		(0.02)	(0.21)	(0.09)	(0.10)	(0.05)		

Table 6—Different methods for hedonic index construction

Panel A of Table 6 shows the average and the standard deviation of the distribution of art returns per country, measured over the same time frames as before, based on two different alternative hedonic index construction methods. First, the hedonic regression is estimated separately on two subsamples for each country, prior to chain-linking the returns (the "adjacent-period" technique). Second, the baseline return series are desmoothed using Equation (7). All returns are USD-denominated, deflated, and logged. Panel B repeats the analysis reported at the bottom of Table 5, using the new return series.

Panel A: Distributions of returns

Country	Time frame	Art returns			
		Adjacent-period		*Desmoothed*	
		Avg.	S.D.	Avg.	S.D.
Australia	1971-2007	2.75%	20.57%	3.46%	28.20%
Austria	1971-2007	2.66%	18.02%	1.91%	22.46%
Belgium	1975-2007	-1.08%	17.24%	0.96%	20.41%
Canada	1972-2007	2.44%	16.08%	2.14%	20.71%
Denmark	1976-2007	1.49%	15.44%	1.40%	18.84%
France	1971-2007	1.24%	18.97%	1.47%	23.57%
Germany	1971-2007	1.78%	12.94%	1.75%	16.50%
Italy	1971-2007	2.03%	17.50%	1.10%	21.08%
Netherlands	1971-2007	2.69%	18.02%	2.81%	24.05%
Sweden	1971-2007	2.38%	20.06%	2.30%	25.09%
Switzerland	1972-2007	1.75%	18.31%	-0.68%	17.87%
U.K.	1971-2007	4.62%	15.69%	4.43%	19.72%
U.S.	1971-2007	3.21%	14.09%	3.71%	18.32%

Panel B: Regressions on fundamentals

Methodology	N	α		Global				Orthogonal				R^2(B)	$\Delta_P R^2$
				β^{GDP}		$\beta^{Equities}$		θ^{GDP}		$\theta^{Equities}$			
Adjacent-period	473	-0.05	**	0.65	***	0.32	***	0.62	***	0.14	***	0.47	0.49
		(0.02)		(0.21)		(0.10)		(0.09)		(0.05)			
Desmoothed	458	-0.04		0.47	*	0.39	***	0.81	***	0.14	**	0.40	0.66
		(0.03)		(0.25)		(0.12)		(0.12)		(0.06)			

Table 7—Repeat sales regressions

Panel A of Table 7 shows the average and the standard deviation of the distribution of art returns per country, measured over the same time frames as before (when possible), based on a standard RSR and a Bayesian RSR. I use all "repeated" transactions (within the same country) of items by the same artist, of the same size, with the same title, of the same medium, and with no differences in the presence of a signature or date. All returns are USD-denominated, deflated, and logged. Panel B repeats the analysis reported at the bottom of Table 5, using the new return series. The model that explains the standard RSR returns also includes an autoregressive term (not shown).

Panel A: Distributions of returns

Country	Time frame	Art returns			
		Standard RSR		*Bayes RSR*	
		Avg.	S.D.	Avg.	S.D.
Australia	1971-2007	2.00%	23.94%	1.41%	13.07%
Austria	1971-2007	-	-	-2.18%	16.85%
Belgium	1975-2007	-	-	-0.45%	18.94%
Canada	1972-2007	3.62%	25.57%	2.20%	11.88%
Denmark	1976-2007	-	-	3.54%	16.41%
France	1971-2007	1.70%	19.88%	1.12%	16.54%
Germany	1971-2007	3.74%	20.07%	1.68%	12.62%
Italy	1971-2007	6.02%	34.57%	1.39%	17.00%
Netherlands	1971-2007	3.69%	28.06%	1.03%	16.43%
Sweden	1971-2007	2.32%	36.13%	0.18%	17.95%
Switzerland	1972-2007	2.69%	23.90%	-0.29%	12.84%
U.K.	1971-2007	3.97%	17.18%	3.05%	14.98%
U.S.	1971-2007	2.91%	14.47%	2.50%	9.86%

Panel B: Regressions on fundamentals

Methodology	N	α		Global				Orthogonal				R^2(B)	$\Delta_P R^2$
				β^{GDP}		$\beta^{Equities}$		θ^{GDP}		$\theta^{Equities}$			
Standard RSR	447	-0.07	**	0.95	***	0.32	***	0.78	***	0.16	*	0.34	0.41
		(0.02)		(0.31)		(0.11)		(0.13)		(0.09)			
Bayes RSR	481	-0.03		0.19	*	0.32	***	0.56	***	0.09	**	0.32	0.89
		(0.02)		(0.07)		(0.11)		(0.08)		(0.04)			

Table 8—Domestic-currency returns

Panel A of Table 8 shows a number of characteristics (average, standard deviation, minimum, and maximum) of the distribution of domestic-currency art returns per country, measured over the longest available time frame. All returns are deflated and logged. Panel A also includes the fraction of volatility in USD returns due to real domestic currency return volatility (V_1) and the portion due to exchange rate volatility (V_2). Panel B repeats the analysis reported at the bottom of Table 5, using the new return series. The global factors are separated out in USD-denominated changes, and changes in the contemporary and lagged inflation-adjusted exchange rates (FX and L1.FX). The orthogonal factors are now the residuals from a regression of the time series of each local factor in the domestic currency on that of the global fundamental in USD.

Panel A: Distribution of returns

Country	Time frame	Art returns						Fractions of volatility	
		Avg.	S.D.	Min.		Max.		V_1	V_2
Australia	1971-2007	2.43%	17.31%	-39.64%	1975	38.20%	1973	0.82	0.18
Austria	1971-2007	1.03%	12.33%	-19.50%	1975	32.25%	2007	0.71	0.29
Belgium	1975-2007	-1.00%	13.97%	-47.26%	1975	30.67%	1988	0.80	0.20
Canada	1972-2007	2.55%	14.86%	-29.46%	1983	24.83%	1980	0.92	0.08
Denmark	1976-2007	1.26%	12.53%	-27.43%	1992	23.80%	2000	0.80	0.20
France	1971-2007	0.35%	16.42%	-56.33%	1991	32.47%	1989	0.87	0.13
Germany	1971-2007	0.68%	8.91%	-16.67%	1976	18.80%	1989	0.68	0.32
Italy	1971-2007	1.32%	13.84%	-29.92%	1976	38.35%	1989	0.78	0.22
Netherlands	1971-2007	1.00%	16.27%	-30.42%	1975	34.24%	1973	0.91	0.09
Sweden	1971-2007	2.43%	16.95%	-56.98%	1991	33.65%	1989	0.84	0.16
Switzerland	1972-2007	0.38%	14.41%	-32.90%	1991	50.34%	1972	0.78	0.22
U.K.	1971-2007	3.60%	14.21%	-40.74%	1991	29.02%	1973	0.90	0.10
U.S.	1971-2007	3.07%	14.31%	-28.73%	1991	33.58%	1973	1.00	0.00

Panel B: Regression on fundamentals

N	α		Global				Currency effects		Orthogonal				R^2(B)	$\Delta_P R^2$
			β^{GDP}		$\beta^{Equities}$		β^{FX}	$\beta^{L1.FX}$	θ^{GDP}		$\theta^{Equities}$			
473	-0.05	*	0.66	***	0.24	**	0.02	0.12	1.49	***	0.14	***	0.22	0.42
	(0.03)		(0.23)		(0.10)		(0.11)	(0.12)	(0.49)		(0.04)			

Table 9—The importance of quality

Panel A of Table 9 shows the average and the standard deviation of the distribution of art returns per country, measured over the time frame 1980–2007 (when possible), for three different quality categories. All sales are first ranked according to the length of the artist's biography in the online art history resource Oxford Art Online. Then three categories are created, based on the word count deciles: top quality (decile 1), medium quality (deciles 2–5), and low quality (deciles 6–10). All returns are USD-denominated, deflated, and logged. Panel B repeats the analysis reported at the bottom of Table 5, using the new return series.

Panel A: Distributions of returns

Country	Time frame	Art returns					
		Top quality		*Medium quality*		*Low quality*	
		Avg.	S.D.	Avg.	S.D.	Avg.	S.D.
Australia	1980-2007	-	-	4.23%	23.13%	3.98%	17.97%
Austria	1980-2007	-	-	2.37%	20.80%	0.32%	17.25%
Belgium	1980-2007	-	-	0.60%	20.80%	-0.64%	16.57%
Canada	1980-2007	-	-	-	-	2.13%	17.34%
Denmark	1980-2007	-	-	1.32%	20.27%	0.90%	16.26%
France	1980-2007	3.21%	28.94%	1.39%	19.34%	1.57%	19.01%
Germany	1980-2007	-	-	0.96%	13.71%	-0.36%	14.55%
Italy	1980-2007	-	-	2.93%	17.04%	2.83%	18.21%
Netherlands	1980-2007	-	-	2.57%	18.81%	1.28%	14.60%
Sweden	1980-2007	-	-	1.56%	25.33%	-0.05%	19.93%
Switzerland	1980-2007	-	-	-	-	-0.72%	14.82%
U.K.	1980-2007	5.95%	17.62%	4.75%	15.23%	4.03%	14.06%
U.S.	1980-2007	4.85%	20.95%	3.78%	14.49%	3.25%	11.13%

Panel B: Regressions on fundamentals

Quality category	N	α		Global				Orthogonal				R^2(B)	$\Delta_p R^2$
				β^{GDP}		$\beta^{Equities}$		θ^{GDP}		$\theta^{Equities}$			
Top quality	180	-0.07	*	0.74	**	0.61	***	0.23		0.07		0.25	0.02
		(0.04)		(0.36)		(0.15)		(0.14)		(0.11)			
Medium quality	445	-0.05	*	0.63	**	0.35	***	0.63	***	0.14	**	0.36	0.49
		(0.03)		(0.24)		(0.10)		(0.11)		(0.06)			
Low quality	464	-0.05	**	0.63	***	0.27	***	0.62	***	0.12	**	0.44	0.57
		(0.02)		(0.19)		(0.09)		(0.09)		(0.05)			

Table 10—Nationality-specific indices

Panel A of Table 10 shows a number of characteristics (average, standard deviation, minimum, and maximum) of the distribution of art returns per nationality, measured over the longest available time frame. All returns are USD-denominated, deflated, and logged. Panel B repeats the analysis reported at the bottom of Table 5, using the new return series.

Panel A: Distribution of returns

Nationality	Time frame	Art returns					
		Avg.	S.D.	Min.		Max.	
Belgian	1965-2007	4.20%	15.91%	-34.45%	1981	32.43%	1968
French	1965-2007	3.24%	18.24%	-59.88%	1991	38.74%	1987
German	1971-2007	4.26%	14.26%	-25.85%	1982	41.62%	1971
Italian	1965-2007	4.20%	15.81%	-30.35%	1991	33.81%	1969
Dutch	1965-2007	3.97%	14.25%	-29.74%	1991	36.24%	1973
Spanish	1971-2007	4.08%	23.60%	-64.08%	1975	44.34%	1987
U.K.	1965-2007	4.11%	15.70%	-37.43%	1975	38.89%	1987
U.S.	1971-2007	3.94%	16.88%	-40.02%	1991	36.49%	1989

Panel B: Regression on fundamentals

N	α	Global				Orthogonal				$R^2(B)$	$\Delta_P R^2$
		β^{GDP}		$\beta^{Equities}$		θ^{GDP}		$\theta^{Equities}$			
336	-0.04	0.62	**	0.45	***	0.46	***	0.03		0.41	0.21
	(0.03)	(0.24)		(0.11)		(0.11)		(0.05)			

Table 11—Control for income inequality

Table 11 repeats the analysis reported at the bottom of Table 5, but adding income distribution variables. Changes in income inequality are proxied by log changes in inverted Pareto coefficients from Atkinson and Piketty (2010).

N	α		Global						Orthogonal						R^2(B)	Δ_P R^2
			β^{GDP}		$\beta^{Equities}$		$\beta^{Inequal.}$		θ^{GDP}		$\theta^{Equities}$		$\theta^{Inequal.}$			
235	-0.08	**	0.75	***	0.36	***	1.27	**	0.72	***	0.17	***	0.00		0.50	0.60
	(0.04)		(0.27)		(0.11)		(0.61)		(0.12)		(0.05)		(0.24)			

Table 12—Art and the equity premium

Panel A of Table 12 uses Equation (8) to estimate the equity premium implied by U.S. art prices. It also shows the premium implied by a standard C-CAPM model, using NIPA data on aggregate consumption and assuming a relative risk aversion of 10. The estimates take into account time aggregation in data (Breeden et al., 1989). The table also reports the standard deviation of each series, the correlation with excess equity returns, and the realized equity premium over the same period. Panel B repeats the analysis using the art indices of the other sample countries. Panel C shows the results using the returns on top-quality art.

Panel A: Implied equity premium for U.S.

Series	Time frame	Standard deviation	Correlation with excess equity returns	Implied equity premium	Avg. realized equity premium
Art	1971-2007	0.191	0.277	1.51%	6.05%
NIPA	1971-2007	0.015	0.137	0.63%	6.05%

Panel B: Implied equity premia for other countries, using baseline art price indices

Country	Time frame	Standard deviation	Correlation with excess equity returns	Implied equity premium	Avg. realized equity premium
Australia	1971-2007	0.177	0.364	2.96%	7.17%
Austria	1971-2007	0.129	0.275	1.84%	6.06%
Belgium	1975-2007	0.140	0.314	2.27%	6.54%
Canada	1972-2007	0.151	0.388	1.85%	4.58%
Denmark	1976-2007	0.135	0.262	1.77%	7.38%
France	1971-2007	0.150	0.530	4.79%	7.49%
Germany	1971-2007	0.090	0.069	0.35%	6.12%
Italy	1971-2007	0.143	0.411	3.62%	4.79%
Netherlands	1971-2007	0.166	0.410	2.97%	8.64%
Sweden	1971-2007	0.161	0.416	4.03%	12.12%
Switzerland	1972-2007	0.160	0.246	1.78%	9.51%
U.K.	1971-2007	0.139	0.450	3.97%	8.04%

Panel C: Implied equity premia for France, U.K., and U.S., using top-quality art price indices

Country	Time frame	Standard deviation	Correlation with excess equity returns	Implied equity premium	Avg. realized equity premium
France	1972-2007	0.295	0.219	4.25%	7.49%
U.K.	1971-2007	0.189	0.525	6.25%	8.04%
U.S.	1972-2007	0.282	0.364	3.86%	6.05%

Appendix Table A—Coefficient estimates of hedonic characteristics

	Australia	Austria	Belgium	Canada	Denmark	France	Germany
TEXTBOOK	-0.4889	0.0328	0.0942	-0.1307	0.0200	0.0861	-0.0354
ATTRIBUTED	-0.8020	-0.7027	-0.4340	-0.9125	-0.7085	-0.7246	-0.5758
STUDIO	-0.3118	-0.7852	-0.1255	-0.4306	-1.0575	-1.0555	-0.4142
CIRCLE	-0.8001	-1.0475	-0.1685	-1.3758	-0.0140	-1.2327	-0.9004
SCHOOL	-1.3284	-1.2864	-0.6261	-1.3711	-1.2336	-1.4554	-0.9621
AFTER	-1.2719	-1.6818	-0.8037	-1.4934	-1.4590	-1.8176	-1.2312
STYLE	-0.6813	-1.4734	-0.4996	-1.2621	-1.1620	-1.6822	-1.0483
SIGNED	0.2445	0.2994	0.2748	0.2818	0.1321	0.3302	0.2232
DATED	0.1376	0.1062	0.1700	0.0583	0.1629	0.1482	0.1736
WATERCOLOR	-0.6209	-0.7906	-0.3770	-0.6776	-0.8467	-0.7200	-0.6251
DRAWING	-1.0115	-1.1444	-0.8424	-1.1497	-1.2020	-1.1837	-1.1433
HEIGHT	0.0433	0.0145	0.0348	0.0358	0.0273	0.0216	0.0342
WIDTH	0.0348	0.0240	0.0253	0.0419	0.0272	0.0224	0.0283
HEIGHT_2	-0.0003	-0.0001	-0.0002	-0.0003	-0.0001	-0.0001	-0.0002
WIDTH_2	-0.0001	-0.0001	-0.0001	-0.0003	-0.0001	0.0000	-0.0001
STUDY	-0.1950	-0.3032	-0.1880	-0.2800	-0.2525	-0.0323	-0.3053
ABSTRACT	-0.3227	-0.1454	-0.0780	-0.2140	-0.1736	-0.0795	-0.0345
ANIMALS	-0.1098	-0.1047	-0.0867	-0.1961	-0.1014	-0.2257	-0.0870
LANDSCAPE	-0.2552	-0.0789	-0.0666	-0.1410	-0.1074	-0.1454	-0.0527
NUDE	-0.1498	0.0469	-0.0110	-0.3008	0.0657	-0.1713	-0.0416
PEOPLE	-0.0606	-0.0051	0.0663	0.0547	-0.0357	-0.0785	-0.0251
PORTRAIT	-0.2846	-0.1514	-0.3787	-0.2105	-0.3958	-0.1419	-0.1983
RELIGION	-0.2068	-0.1660	-0.1628	-0.3317	-0.3352	-0.1357	-0.0695
SELF-PORTRAIT	0.0722	-0.0192	0.1652	0.4971	0.0386	0.3073	0.1885
STILL_LIFE	-0.1683	0.2144	0.0509	0.2343	0.2074	0.0415	0.1416
UNTITLED	-0.2538	-0.0833	-0.0438	-0.3930	-0.0356	-0.0397	-0.0457
URBAN	0.0142	0.0570	0.0008	-0.0822	0.0253	0.1070	0.0258
FEBRUARY	1.4102	0.0151	0.1493	0.0558	0.1726	0.0072	0.2493
MARCH	1.0684	0.4046	0.2102	0.0171	0.1554	0.1592	-0.1129
APRIL	1.0922	0.2647	0.1649	-0.0511	0.1946	0.1058	-0.1250
MAY	1.1533	0.4630	0.2838	0.1646	0.1217	0.0869	0.1314
JUNE	1.1906	0.2101	0.0144	0.0109	0.1368	0.2098	0.1356
JULY	1.1079	0.0901	-0.4758	-0.1220	-0.4674	0.0165	-0.1386
AUGUST	1.0848	0.4654	-0.1595	0.0953	0.1397	0.3108	-0.2733
SEPTEMBER	1.1477	0.3104	-0.0181	-0.1348	0.1664	-0.0907	-0.0386
OCTOBER	0.9966	0.3588	0.2548	0.0957	0.1796	0.1013	-0.0382
NOVEMBER	1.0392	0.4213	0.2458	0.1919	0.2318	0.1874	0.1995
DECEMBER	1.0798	0.3984	0.2149	0.0978	0.1837	0.2000	0.0693
SOTH_LONDON	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
SOTH_NY	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
SOTH_OTHER	0.4360	1.5028	-0.0220	0.1089	0.3611	0.2697	0.4980
CHR_LONDON	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
CHR_NY	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
CHR_OTHER	0.3368	0.5366	0.1678	0.2135	0.0000	0.3235	0.2401
BON_LONDON	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BON_OTHER	-0.1354	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PHIL_LONDON	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
PHIL_OTHER	-0.1005	0.0000	0.0000	-0.0398	0.0000	0.0000	-0.0960
AUCTION_EUROPEAN	N.A.	-0.3884	N.A.	N.A.	-0.0418	0.0577	0.0617
AUCTION_AMERICAN	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

	Italy	**Netherl.**	**Sweden**	**Switzerl.**	**U.K.**	**U.S.**
TEXTBOOK	0.1145	-0.0152	-0.2922	0.0602	0.1361	0.1364
ATTRIBUTED	-0.6701	-0.6628	-0.4845	-0.7878	-0.6129	-1.0196
STUDIO	-0.8635	-0.7308	-0.3520	-0.8980	-0.7460	-1.2227
CIRCLE	-1.0159	-0.9302	-0.4190	-0.9359	-0.8702	-1.3986
SCHOOL	-1.2278	-1.2168	-0.9327	-1.2706	-0.8706	-1.7396
AFTER	-1.8337	-1.7242	-1.1875	-1.4559	-1.6769	-2.2311
STYLE	-1.3646	-1.4826	-0.8952	-1.4317	-1.3335	-2.0222
SIGNED	0.1927	0.2132	0.2146	0.3425	0.2569	0.2424
DATED	0.1329	0.1848	0.2161	0.1714	0.1668	0.1471
WATERCOLOR	-0.9890	-0.6475	-0.6567	-0.7024	-0.6979	-0.7492
DRAWING	-1.0384	-0.9639	-1.1140	-1.2413	-1.0514	-1.1140
HEIGHT	0.0276	0.0165	0.0253	0.0306	0.0140	0.0261
WIDTH	0.0237	0.0263	0.0307	0.0324	0.0243	0.0268
HEIGHT_2	-0.0001	-0.0001	-0.0001	-0.0002	0.0000	-0.0001
WIDTH_2	-0.0001	-0.0001	-0.0002	-0.0001	-0.0001	-0.0001
STUDY	-0.4102	-0.1334	-0.4505	-0.4880	-0.1846	-0.1992
ABSTRACT	-0.1370	0.0854	-0.1384	-0.0520	-0.1371	-0.0874
ANIMALS	-0.1601	-0.0654	-0.0372	-0.0946	-0.1839	-0.2186
LANDSCAPE	-0.0447	-0.0184	-0.1929	-0.0231	-0.1270	-0.1755
NUDE	-0.4389	0.0984	-0.0585	-0.1737	-0.1433	-0.1582
PEOPLE	-0.0331	-0.0082	-0.0366	-0.0207	-0.0231	-0.0351
PORTRAIT	-0.1198	-0.3253	-0.3982	-0.1946	-0.1706	-0.2868
RELIGION	0.0643	-0.1336	-0.0734	-0.1820	-0.1205	-0.0973
SELF-PORTRAIT	-0.1710	-0.1078	-0.2662	0.0577	0.2477	0.1573
STILL_LIFE	0.0789	-0.0726	0.0182	0.0157	0.0545	-0.0215
UNTITLED	-0.1611	-0.1130	-0.1214	-0.0160	-0.1870	-0.1778
URBAN	0.0592	0.0044	0.0344	0.0306	0.0915	0.0088
FEBRUARY	-0.0687	0.2539	0.1002	0.2031	0.1131	-0.3074
MARCH	-0.1727	0.4054	0.4144	0.3127	0.3088	-0.3400
APRIL	-0.2031	0.7511	0.7050	0.2609	0.3626	-0.1265
MAY	-0.2072	0.7515	0.7157	0.2970	0.1930	0.1317
JUNE	-0.2223	0.5913	0.3450	0.4588	0.4485	-0.2777
JULY	-0.3428	-0.1012	-0.7768	0.3569	0.4398	-0.3657
AUGUST	-0.5019	-0.1656	-0.2078	-1.0381	0.0486	-0.1194
SEPTEMBER	-0.2537	0.1150	0.0973	0.2459	0.1102	-0.3997
OCTOBER	-0.1603	0.7178	0.8088	0.2112	0.1380	-0.1965
NOVEMBER	-0.1809	0.7327	0.6998	0.2915	0.4470	0.1250
DECEMBER	-0.1814	0.7246	0.6516	0.3226	0.4877	0.0113
SOTH_LONDON	N.A.	N.A.	N.A.	N.A.	0.9541	N.A.
SOTH_NY	N.A.	N.A.	N.A.	N.A.	N.A.	0.9354
SOTH_OTHER	0.0613	0.4738	0.9982	0.4957	0.2027	0.8353
CHR_LONDON	N.A.	N.A.	N.A.	N.A.	0.9847	N.A.
CHR_NY	N.A.	N.A.	N.A.	N.A.	N.A.	0.8316
CHR_OTHER	-0.0426	0.4625	0.0000	0.7249	0.1559	0.7005
BON_LONDON	N.A.	N.A.	N.A.	N.A.	0.3284	N.A.
BON_OTHER	0.0000	0.0000	0.0000	0.0000	-0.2809	0.1114
PHIL_LONDON	N.A.	N.A.	N.A.	N.A.	0.4996	N.A.
PHIL_OTHER	0.0000	0.0488	0.0000	0.7279	0.0748	0.5514
AUCTION_EUROPEAN	0.0023	N.A.	0.1046	0.2557	0.1847	N.A.
AUCTION_AMERICAN	N.A.	N.A.	N.A.	N.A.	N.A.	0.1185

Appendix Table B—Art returns (USD-denominated, deflated, and logged)

	Australia	Austria	Belgium	Canada	Denmark	France	Germany
1971	0.0270	0.2785				-0.0426	-0.0014
1972	0.0188	-0.0354	-0.1012	0.1397	0.2902	0.2043	0.1077
1973	0.6666	0.3512		0.1309	0.4177	0.2240	0.0153
1974	-0.1925	0.0117		-0.1712		-0.0273	0.1964
1975	-0.4040	-0.1870	-0.4430	-0.0061		-0.3459	-0.0662
1976	-0.2377	-0.1284	0.1099	-0.1780	0.1298	-0.2837	-0.1733
1977	0.0191	0.0585	-0.0964	0.1499	0.0366	0.0193	0.0822
1978	0.0100	0.2321	0.2084	-0.0570	0.0847	0.1646	0.1100
1979	0.1188	-0.0263	-0.0035	0.2024	0.0293	0.0833	0.1485
1980	0.2912	0.0401	-0.0494	0.2153	-0.1330	-0.0507	-0.0739
1981	0.0577	-0.3840	-0.3733	-0.1425	-0.4196	-0.1561	-0.2808
1982	-0.2859	-0.2181	-0.1654	-0.1740	-0.2202	-0.1617	-0.1741
1983	-0.0157	0.0137	-0.0656	-0.2719	0.1619	0.0044	-0.0346
1984	0.0030	-0.0982	-0.1417	-0.1876	0.0612	0.0437	0.0227
1985	0.0648	-0.0387	0.1300	0.1448	0.1665	0.0998	0.0587
1986	0.2707	0.2876	0.3857	0.0595	0.2138	0.3974	0.2587
1987	0.1830	0.2584	0.1534	0.2454	0.2966	0.3844	0.2053
1988	0.3169	0.0752	0.2916	0.2508	0.1109	0.1427	0.1319
1989	-0.0650	0.0745	0.1494	0.1049	0.0321	0.2373	0.0900
1990	-0.3268	0.3184	0.0237	-0.1369	0.0075	0.1669	0.1580
1991	-0.2080	-0.1676	-0.1472	-0.1667	-0.2789	-0.6103	-0.1691
1992	-0.0490	-0.1344	-0.1454	-0.0749	-0.2311	-0.1638	-0.0667
1993	-0.2486	-0.0383	-0.1937	-0.2489	-0.1310	-0.2127	-0.1953
1994	0.0847	-0.0679	-0.0920	0.0273	0.0160	-0.0042	-0.0063
1995	-0.0151	0.0633	0.1534	-0.0621	0.0212	-0.0011	0.0624
1996	0.1794	-0.0961	-0.2296	-0.0193	-0.0014	-0.1040	-0.1400
1997	0.0623	-0.1355	-0.0108	0.0384	-0.1024	-0.0704	-0.1167
1998	-0.1236	0.0800	0.0679	-0.1275	0.1481	0.0669	0.0370
1999	0.2595	0.0172	-0.0688	0.1880	-0.1099	0.0154	-0.0557
2000	-0.0555	-0.1707	-0.1965	0.0277	0.0853	-0.0663	-0.1200
2001	-0.0869	-0.1346	0.0928	-0.1003	-0.0813	-0.0168	-0.0683
2002	0.0522	0.1836	0.0622	0.1429	-0.0376	0.0998	0.0516
2003	0.2258	0.2064	0.1285	0.1049	0.1780	0.0838	0.2454
2004	0.0854	0.0837	0.0573	0.2831	0.1215	0.0753	0.0589
2005	-0.0180	-0.0461	0.0672	0.0061	0.1002	-0.0308	0.0102
2006	0.0656	0.0295	0.0062	0.2507	0.1609	0.1066	0.0584
2007	0.4132	0.3776	0.0380	0.2618	0.1430	0.1505	0.1966

	Italy	Netherl.	Sweden	Switzerl.	U.K.	U.S.
1971	0.2663	-0.1076	0.0720		0.1259	-0.0998
1972	0.0307	0.0851	0.3456	0.7563	0.2016	0.1675
1973	0.1468	0.4874	0.2314	-0.0509	0.2979	0.3358
1974	-0.0231	0.0972	0.2195	-0.0729	-0.2502	-0.1886
1975	-0.1784	-0.2942	-0.0813	-0.1053	-0.2587	-0.2219
1976	-0.4180	0.2593	-0.0135	-0.0828	-0.0412	-0.0906
1977	0.0104	-0.1078	-0.0328	0.1169	0.0182	-0.0542
1978	-0.0201	-0.1720	-0.1707	0.1853	0.2239	0.1707
1979	0.1052	0.0873	0.1361	0.0064	0.1133	0.0931
1980	0.0559	-0.0510	-0.0752	-0.0297	0.0122	0.0726
1981	-0.0786	-0.4426	-0.3181	-0.1724	-0.1168	-0.0097
1982	-0.0637	-0.1761	-0.1987	-0.2032	-0.2381	-0.1390
1983	-0.0136	0.0751	0.0393	-0.1051	0.0333	0.0663
1984	-0.1696	-0.1837	0.1730	-0.0511	0.0857	-0.0109
1985	-0.0002	0.1414	0.0919	0.0460	0.1171	0.0567
1986	0.3666	0.2815	0.2824	0.2957	0.2328	0.1109
1987	0.3245	0.1925	0.4456	0.2203	0.3047	0.2838
1988	0.1929	0.1563	0.1504	0.1630	0.2475	0.1979
1989	0.3252	0.1820	0.2799	0.1715	0.1602	0.3342
1990	0.2323	0.2022	-0.2742	0.0864	0.1282	-0.1135
1991	-0.3030	-0.3059	-0.5516	-0.3899	-0.3866	-0.2873
1992	-0.2097	-0.0862	-0.0909	-0.0405	-0.0816	-0.0615
1993	-0.3068	-0.1013	-0.3280	-0.1757	-0.1748	-0.1381
1994	-0.0929	0.0342	0.0527	0.0155	0.0175	-0.0087
1995	0.1505	0.0561	0.0369	0.0617	-0.0001	-0.0397
1996	-0.0543	0.0222	0.0389	-0.2082	0.0725	0.0164
1997	-0.1052	0.0582	-0.1210	-0.0641	0.0555	0.0969
1998	0.0017	0.0436	0.0141	-0.0332	0.0174	0.0313
1999	0.0310	0.1036	0.0168	-0.0737	0.0889	0.0956
2000	-0.0775	-0.1398	-0.0757	-0.0833	0.0588	0.1066
2001	-0.0397	-0.0769	-0.1548	0.0102	-0.0552	-0.0943
2002	0.1505	0.1502	0.1444	0.0460	0.0666	0.1097
2003	0.2304	0.0943	0.2090	0.0450	0.1398	-0.0422
2004	0.0695	0.0472	0.1345	0.1602	0.1506	0.0589
2005	0.1015	-0.0176	-0.0606	0.0196	-0.0126	0.0070
2006	0.0502	0.2101	0.0936	0.0890	0.1670	0.1248
2007	0.0472	0.0469	0.1974	0.1619	0.1811	0.1988

Figure 1—Art price indices for France, Italy, the Netherlands, the U.K., and the U.S.

This figure shows the log art price index values (in real USD) for the five largest art markets. The indices are set equal to one in 1970. More information on the distribution of art returns per country can be found in Table 2.

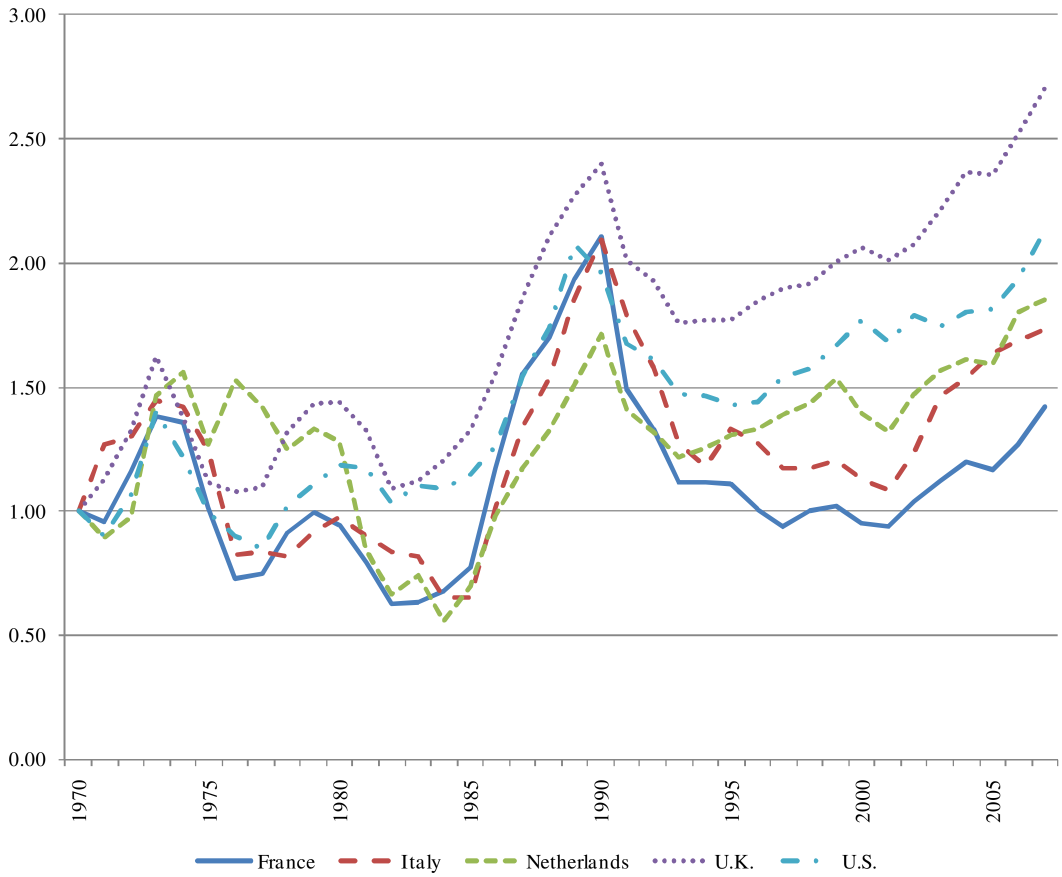
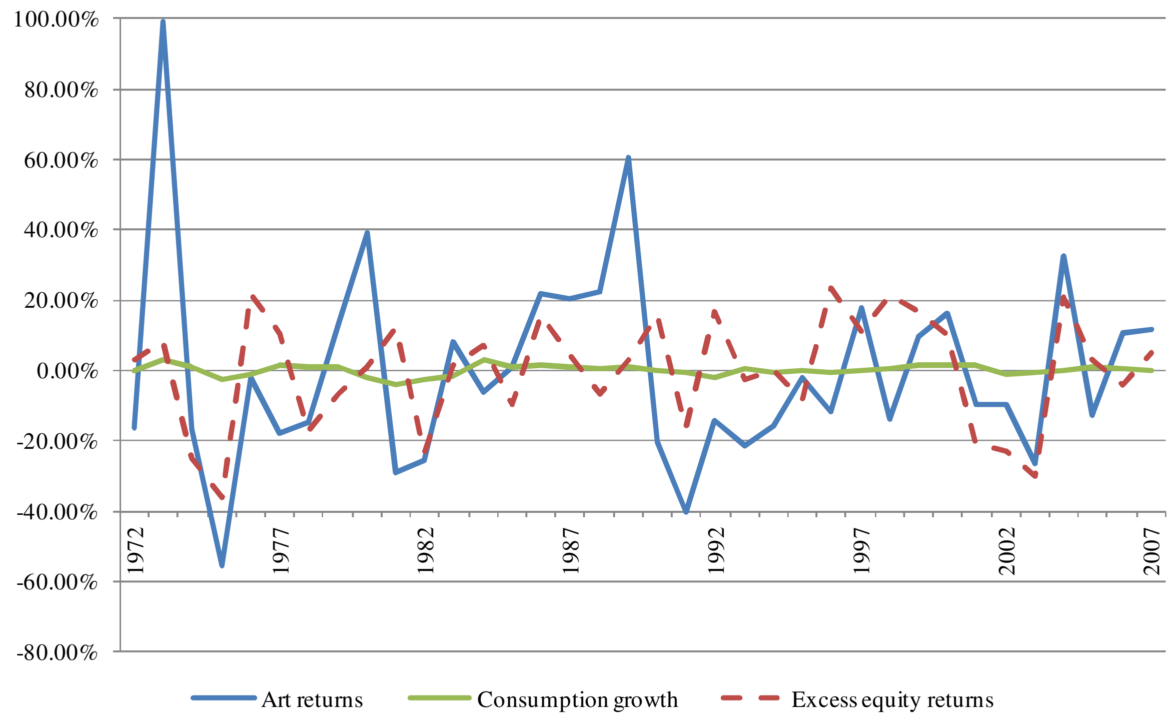


Figure 2—Response of art prices and aggregate consumption to excess equity returns

This figure shows top-quality art returns, changes in aggregate consumption, and excess equity returns for the U.S. over the period 1972–2007. More information on the distribution of top-quality art returns can be found in Table 9. Data on equities and risk-free yields come from Global Financial Data. Consumption growth is calculated using NIPA data on consumption of non-durable goods and services. All variables are USD-denominated and deflated. All series are normalized to have zero mean.



Chapter 6

Ex post: The investment performance of collectible stamps

Abstract: This paper uses stamp catalogue prices to investigate the returns on British collectible postage stamps over the period 1900–2008. We find an annualized return on stamps of 7.0% in nominal terms, or 2.9% in real terms. These returns are higher than those on bonds but below those on equities. The volatility of stamp prices approaches that of equities. Stamp returns are impacted by movements in the equity market, but the systematic risk of stamps remains low. Stamps partially hedge against unanticipated inflation. Estimates of average after-cost returns for individual investors show that stamps may rival equities in terms of realized performance.

While non-pecuniary benefits like the aesthetic enjoyment of a collection of stamps or the pride in having secured a rare issuance surely motivate amateur stamp collectors, investors are more interested in how high-end stamps perform as an asset class. Just like other collectibles, stamps are often considered a comparatively safe investment in times of financial turmoil, and one that potentially hedges better against changes in the aggregate price level. For example, *The Wall Street Journal* (2009) recently showed how investors who are worried about the economy and future inflation are crowding out casual hobbyists in the market for collectible U.S. coins. In Great Britain, the credit crunch has made investors turn to collectibles, reportedly in the hope that coins and stamps can offer a "cycle-resistant alternative" to traditional financial assets (The Times, 2008).

To serve stamp collectors' and investors' need for a reliable price index, stamp dealer and catalogue publisher Stanley Gibbons launched the Stanley Gibbons Great Britain 30 Rarities index (SG GB30) in 2004. The SG GB30 aggregates the catalogue prices for 30 scarce British stamps—a collecting area in which there is global interest—that were worth at least 10,000 GBP at the time of index construction. It is the first transparently managed stamp index; in contrast, Stanley Gibbons has never revealed the (changing) composition of its worldwide SG100 index which was created in 2002. The stamp dealer has often referred to the good performance of the SG GB30 on its Web site and in its publications. However, three problems with the index come to the fore. First, Stanley Gibbons has back-tracked the stamp values to report annualized returns since as early as the 1970s (Gibbons Stamp Monthly, 2006a). The index thus suffers from a typical look-ahead bias (Dimson, Marsh, and Staunton, 2002): the back-tracked price evolution of the constituents of the SG GB30 may not be representative of the overall price trend in the market for British collectible stamps. Second, even abstracting from the previous problem, the index does not allow one to take a very long-term view on stamp investments, since valuations for some constituents have not been available for a sufficiently long period. Third, the SG GB30 also contains rare plates and non-regular stamp types, which are likely to be especially thinly traded.

It is not the first time that a firm dealing in collectibles has created its own price index. Consider, for example, the Sotheby's Art Index, which was run in the 1980s by the famous auction house. The index values were based on the appraised values of works of art, as estimated by Sotheby's experts. Shiller (1993) argued that the index "must reflect a lot of guess work" and "would appear to have even greater potential problems than the appraisal-based indexes of commercial real estate." Nevertheless, with the impressive performance of the index in hand, Sotheby's could convince potential art buyers that the art market was full of lucrative investment opportunities (Lacey, 1998). Sotheby's discontinued their index soon after the art market crash of 1991.

In this paper, we look into the returns on British collectible postage stamps over the very long run, based on Stanley Gibbons catalogue prices. After describing price trends in the early decades of stamp collecting, we construct a stamp price index that starts in 1900, using the arithmetic repeat-sales methodology developed by Shiller (1991). We compare the resulting returns on stamps to those reported by Stanley Gibbons itself, and to the returns on a range of financial and non-financial assets. As stamp collecting is a form of luxury consumption, changes in affluent individuals' wealth can be expected to drive the market for stamps (Aït-Sahalia, Parker, and Yogo, 2004; Hiraki, Ito, Spieth, and Takezawa, 2009). Therefore, we investigate the relation between stamp returns and equity market movements. We also examine the degree to which stamps are a hedge against both expected and unexpected inflation. Finally, we give rough estimates of the realized returns of individual investors in equities and stamps after transaction costs.

Since 1900, our stamp price index has shown an annualized nominal return of 7.0%, and an annualized real return of 2.9%—a performance that is between the returns on bonds and equities, but comparable to that of art. There have been remarkably higher returns on stamps in some boom periods, for example in the second half of the 1970s and during recent years. However, there have also been extended periods of real price depreciation. After unsmoothing the real stamp return series, we find that the volatility of these returns is much higher than that of bonds and closer to equities. Once we account for non-synchronous trading, stamp returns are positively correlated with stock market movements. The beta of stamps is still relatively low, though, indicating that investors in stamps are only modestly exposed to systematic risk. We find that stamps are a hedge against expected inflation (like most assets), and there also is some evidence that they hedge against unexpected inflation (like gold). Finally, taking account of differences in holding periods and transactions costs, we find that the average annual realized return of a stamp investor can match the after-cost return of the average equity investor.

Our paper contributes to the literature in several respects. First, it contains a complete examination of the stamps market since its inception, and provides a price index for stamps since 1900. The construction of this index enables an unprecedented evaluation of the long-term investment performance of stamps. Second, our study extends the existing evidence on the relation between collectible prices on the one hand and equity markets and inflation on the other. Third, unlike previous work, we formally investigate the impact of differences in transaction costs and holding periods on the relative performance of this important collectible. Fourth, this paper will at times draw comparisons with the markets for art and gold, shedding new light on the dynamics of real asset prices.

The remainder of this paper is structured as follows. The next section contains a short history of stamp collecting and investing. Section 2 reviews the existing academic literature on stamp investments. Section 3 describes our data collection and methodology, while Section 4 reports the results of our research. Section 5 concludes and outlines future work.

1. A short history of stamp collecting and investing

Belk (1995) describes collectors as individuals who passionately, and sometimes even obsessively, search and shop for unique but in essence useless items, such as obsolete postage stamps. Stamp collecting has been an established pastime almost since the introduction of the Penny Black, the world's first prepaid adhesive stamp which was issued in the U.K. in 1840 (Johnson, 1920). Gelber (1992) reports that the hobby's first participants were women and children, who took an aesthetic interest in stamps. As stamps became marketplace commodities over the years, and as trading became a more important aspect of collecting, women and girls were replaced by men and boys.

Stamps first became a fad asset in the 1860s, and stamp collecting gave rise to “an intense market-based subculture” (Gelber, 1992). The earliest professional dealers had by then already set up business, and periodicals and catalogues started to emerge.

Lucking-Reiley (2000) presents evidence of the use of several types of auctions in the late nineteenth century stamp market. Not much later, international expositions were attracting philatelists from around the world, and collectible stamps could possess significant financial value. *The New York Times* (1913) reported that art-dealer Henry J. Duveen’s stamp collection, displayed at the 1913 International Stamp Exhibition in New York, was worth over 0.25 million USD (if invested till 2010 in U.S. equities this would be 1.6 billion USD). According to *Time* (1955), the world’s most valuable stamp collection was worth 2.5 million USD in 1955 (if invested till 2010 in U.S. equities this would be 0.5 billion USD). Even in wartime, stamp collecting continued (The New York Times, 1920; Gibbons Stamp Monthly, 2006b).

Satchell and Auld (2009) report that stamp collecting reached its zenith in the 1960s and 1970s. In August 1966, riots broke out in London for a new and relatively limited issue of stamps that celebrated England’s victory at the soccer world cup (Lake, 1970). Such was the demand that sheets of the stamps were quoted on the London Stock Exchange for a short time. The highly inflationary environment of the 1970s made investments in collectibles particularly attractive: stamps became a way “to lick inflation” (The Times, 1974). In the 1980s, however, speculative demand for many collectibles disappeared as inflation fell (Stoller, 1984).

Despite the bust of the 1980s and the lower interest among younger generations, stamp collecting remains one of the world’s most popular hobbies, especially among the more affluent (Satchell and Auld, 2009). The tens of millions of stamp collectors worldwide annually spend up to 10 billion USD on their hobby (Reuters, 2006). The extensive global network of auction houses (now joined by online auction sites) and dealers, the existence of catalogues containing reference prices, and the ease of storage and transfer have ensured a relatively high liquidity of stamps throughout modern times.

Although stamp collecting has historically been underpinned by a market-based model of investing and trading, the philatelic literature has long discouraged buying stamps solely for the purpose of financial gain (Gelber, 1992). Nevertheless, speculation in stamps has always existed, and even committed philatelists have often dreamt of “striking it rich” (Gelber, 1992). Burton and Jacobsen (1999) show that many of today’s collectors hope for financial gains. One respected investment professional, who is said to have invested over 100 million USD in rare stamps selected through top-down valuation techniques, noted after the 2007 sale of his British collection that the return had been “better than the stock market” (Gross, 2008).

2. Related literature

Collectibles have been discussed in several strands of the economics literature. There is, of course, a sizeable body of research on art investments, including Goetzmann (1993), Mei and Moses (2002), Ashenfelter and Graddy (2003), and Renneboog and Spaenjers (2010). However, scholars have also investigated the markets for wine, coins, violins, and other collectibles, for which studies of returns are reviewed by Burton and Jacobsen (1999). Relatively few studies have looked into the long-term returns on stamps, a gap that is especially striking given the financial values involved. Most prior studies utilize U.S. data, and consider relatively short time frames. Taylor (1983) applies a signal extraction method on transaction prices of the five most frequently auctioned stamps in his sample period to estimate quality-adjusted returns. He finds an average yearly return of 12.2% between 1963 and 1976. Cardell, Kling, and Petry (1995) also start from auction prices, but cover the period 1947–1988. They report an upward (and accelerating) trend until 1980, with a fivefold price increase between 1976 and 1980. Thereafter, prices decline and level off.

A fundamental question is whether stamps can function as a hedge against inflation or movements in financial markets. Cardell, Kling, and Petry (1995) and Thiel and Petry (1995) find that the returns on U.S. stamps are positively related to expected inflation over different time frames. With respect to portfolio diversification, Veld and Veld-Merkoulova (2007) suggest that there may be benefits from investing in British stamps. When applying a capital asset pricing model to the SG100 index, the authors find positive alphas, and betas that are close to zero. Even though the results are based on no more than four years of data, they seem to confirm previous findings on American data by Taylor (1983) and Cardell, Kling, and Petry (1995) that most of the risk of stamp investments is unsystematic relative to the equity market.

3. Data and methodology

To look into the long-term returns on British stamps, we need to construct a history of prices. Stamp prices are recorded in four standard, worldwide catalogues that are published on a periodic basis. They are the Stanley Gibbons Stamp Catalogue (U.K.), the Michel Katalog (Germany), the Scott Standard Postage Stamp Catalog (U.S.A.), and the Yvert et Tellier Catalogue de Timbres-

Poste (France). While there are also other worldwide catalogues that are no longer in production and a substantial number of single-country catalogues, these four reference sources have been published for many years on an annual (or sometimes less frequent) cycle. Some consistency is maintained between successive editions, but there are no attempts to ensure consistency between publishers' catalogues. A time series of prices is therefore best constructed from a single publisher's catalogue. Since our focus is on British stamps, the authoritative data source is the Stanley Gibbons publication.

In 1865, nine years after he started selling stamps, Edward Stanley Gibbons published a first 'Descriptive Price List and Catalogue of British, Colonial and Foreign Postage Stamps.' The price lists were issued monthly, but contained few entries. For example, the November 1865 list included prices for only eight used (and for zero unused) British stamps. The price lists were the forerunners of a long series of Stanley Gibbons catalogues, the first edition of which was published in 1879. Since the early catalogues were hardly complete and did not yet include classification numbers, it is not possible to link them with twentieth century editions. However, to give an idea of price trends prior to 1900, Figure 1 shows the evolution of the total value of the eight used stamps included in the 1865 price list, as recorded in the price list itself, and in all catalogues published (on an irregular basis) up to 1900. For reasons of comparison, we also show how the price of an unused Penny Black—for which we have complete pricing information since the first catalogue in 1879—changes over the years. Figure 1 also shows the total number of regular British adhesive stamps in each catalogue.

[Insert Figure 1 about here]

Figure 1 shows a relatively steady increase in stamp prices between 1865 and 1890. At the end of the nineteenth century, however, our portfolio of eight used stamps rises dramatically in value. Between 1890 and 1895, the aggregated catalogue values increase to 0.90 GBP from 0.21 GBP. The unused Penny Black follows a very similar trajectory. It thus seems that the growing demand from collectors first exerted pressure on stamp prices around 1890. It is telling that it took until 1891 for the "market value" of our portfolio of used stamps to surpass its "book value," measured as the sum of the nominal stamp values.

Furthermore, Figure 1 illustrates the strong growth in the number of entries over the years. Of course, the population of existing stamps grew naturally over time, but old issues also came to be catalogued more exhaustively. While only eight British stamps were included in the 1865 price list, the number of constituents rose to 215 by 1895. There again seems to have been a structural break between 1891 and 1895. Closer inspection of the catalogues reveals that the 1891 edition was the first one with a (preliminary) numbering system, while the 1895 edition catalogue saw a marked increase in the number of varieties that were assigned classification numbers. For example, while previous editions only included the common Penny Black ("1d., black"), for which the price evolution is shown in Figure 1, the 1895 catalogue also displayed prices for varieties like "1d., intense black (early impression)" and "1d., grey-black (worn plate)."

By the start of the twentieth century, the Stanley Gibbons catalogues, with their newly introduced and very detailed classification system, had become the main source of reference for collectors of British stamps. To build a frequently updated price index, we consult all stamp price catalogues that have been published since then by Stanley Gibbons (1900–2008). We assign every catalogue to the year-end that is closest to the publication date, as inferred from the publication timing stated in the catalogue or from the British Library's acquisition date-stamp. All but ten catalogues were published in the second half of the year. The first catalogue considered for this research is the 13th edition that was published in January 1900; the last one is the 111th edition that was published at the end of 2008. The latter catalogue includes about 3,000 regular issues, and for many of these stamps also lists prices for special varieties, sets, and first day covers. There were no catalogues for the end of 1900, 1916, 1918, 1942, and 1945 (coinciding with the Boer and World Wars); nor for 1905, 1909, 1921, 1923, 1947, and 1950.

We start by identifying the 50 most valuable British stamps in the first catalogue, published at the start of 1900. We then update our list of collectible stamps every nine years (until end-1998), by adding those stamps to the list that are among the 50 most valuable ones at that point in time. If there is more than one stamp with the cut-off value, we include the oldest one in our data set, since collectors are often more concerned with earlier stamps. We include both unused and used stamps in our analysis. We do not consider special varieties,[1] and we exclude issues of postage due stamps, control letters, and other non-regular stamps. We do not delete or replace stamps.

Restricting ourselves to an initial list of 50 stamps and performing an update every nine years makes our procedure manageable, and maintains the focus on investment-grade stamps. Also, by choosing an interval of nine years, we avoid calendar years in which no catalogue was published.

[1] Special varieties are not attributed a main Stanley Gibbons classification number (such as *15* or *23a*) and have different colors, watermarks, or plate numbers, or contain printing errors. Until 1917, these (sometimes unique) varieties were not even included in the general list of stamps in the catalogues. An exception to the rule that we exclude these varieties is made for stamps that were already included in our database as regular types.

Figure 2 shows the two (unused) stamps that have consistently been in the top-50 of most valuable stamps since end-1899, namely those with classification numbers *5* (2d., blue, issued in 1840, and a value of 27,000 GBP in 2008) and *121* (2s., brown, issued in 1880, and a value of 20,000 GBP in 2008).

[Insert Figure 2 about here]

For each stamp thus identified, we track the prices from that point forward, taking into account changes in classification numbers when necessary. Figure 3 illustrates the growing total number of stamps for which we follow prices over time, partitioned into the number of observations per year for which we have price information and the number of missing prices, from edition 13 to edition 111 of the Stanley Gibbons catalogue. In general, the proportion of missing prices is low. We can have missing observations for two reasons. First, especially in the earliest catalogues, it sometimes happens that a stamp is included but that no price is quoted, for example because Stanley Gibbons did not have the item in stock. Second, a stamp can exceptionally be omitted completely from the catalogue. When this happens (on only four occasions in 109 years), we assume a loss in value of 90%, to reflect the possibility that a stamp is deleted for reasons that are correlated with impaired value.

[Insert Figure 3 about here]

As explained before, we start following 50 stamps at the start of the twentieth century, but update our list every nine years. By the end of our time frame, we track prices for 127 stamps in total.[2] The growth mainly takes place in the first decades when each new edition saw a marked increase in the number of stamps for which valuations were available. Fewer stamps have to be added to our sample later on. That the list of most valuable stamps has been relatively stable over time indicates that changing tastes are less of an issue than in the art market, for example. Though they were eligible, no stamps that were issued subsequent to 1935 enter our sample. An underlying issue is what determines the (relative) value of a stamp. Next to quality, rarity definitely plays a role. For regular stamp issues, the rarity of stamps may be mainly a function of the quantity issued and age (Schnitzel, 1979). Even though some of the earliest stamps were originally printed in editions of millions, only a limited number of copies have survived undamaged. Franses (2007) shows that the number of extant copies of collectible stamps also depends on the nominal value of the stamp and

[2] The detailed list of all stamps included in this research can be obtained from the authors on request.

the length of the period during which the stamp was valid. Typically, unused stamps of an issue are worth considerably more than the used stamps, though there are exceptions.

Besides information on the magnitude of our sample, Figure 3 includes the price evolution of the least expensive and most expensive stamps in our sample over our time frame. During the first years, the lowest value is about one pound, while the most valuable item was priced at less than ten pounds. These figures increase dramatically over time, but the trends are very similar, even though the sample grows significantly. At the end of 2008, the most expensive stamp in our data set is worth 150,000 GBP, while the least valuable one is worth 550 GBP.

The Stanley Gibbons catalogue prices reflect both the company's own experience in supply and demand, and competitors' auction realizations, dealer prices, or catalogue prices. Prices are always for examples in fine condition, whether used or unused. They represent the estimated selling prices of Stanley Gibbons at the time of publication of the catalogue. Although catalogue prices may not always reflect market conditions as accurately as auction prices, they have historically constituted a "faithful barometer" of actual market values (Wagenheim, 1976). The price listed in Stanley Gibbons' catalogues is typically considered an upper estimate of a stamp's market value, since it includes a dealer's premium. However, this is less relevant in the case of high-end stamps, the category of interest in this study, since fixed dealer costs like storage, handling, and marketing are only a fraction of their value. Still, comparing the Stanley Gibbons catalogue prices of the stamps in our sample in 2008 to the market values from Thomas (2009) shows that collectible stamps trade at an average discount of about 20% compared to the catalogue value. Part of this price difference can probably be explained by the high seller reputation of Stanley Gibbons (Dewan and Hsu, 2004). However, it is important to note that a constant proportional discrepancy between catalogue and market values cannot bias the annualized returns that we estimate.

By their very nature, the stamps that we consider do not transact very often. Precise numbers are elusive, but it is clear that many of the stamps in our sample only trade once every few years, at least in the fine condition for which values are reported in stamp catalogues. However, close substitutes like varieties and lesser-quality copies set benchmarks for the included stamps on a much more regular basis. For example, according to market participants, thousands of Penny Blacks are bought and sold every year, but the copies vary widely in condition (and in other price-determining dimensions like plate number or margin width).

Our data set underpins a more consistent and longer-term analysis of the price trends of stamps than was previously possible. We apply the value-weighted arithmetic repeat-sales methodology as developed by Shiller (1991) to our price series. Repeat-sales regressions are typically used to estimate the returns on portfolios of assets that are infrequently traded, such as real estate or art. The methodology is particularly useful in our case because it adequately addresses the problem of price quotes that are temporarily missing. Repeat-sales regressions start from the purchase and sale date and price of each object, but different variations of the methodology exist. Shiller (1991) argues that his arithmetic method, which uses absolute prices instead of log prices, results in an index that represents the value of a portfolio of assets better than indexes based on geometric estimation methods. Weighting by value gives rise to an index that represents the total value of the stamps in our sample. Alternative repeat-sales approaches are reviewed in Goetzmann (1992) and Ginsburgh, Mei, and Moses (2006), among others.

4. Empirical results

4.1. An index for postage stamps

Table 1 reports the results of our arithmetic repeat-sales regressions.[3] For missing years, the index values are geometrically interpolated. The same table also shows the implied nominal returns. Table 2 repeats the analysis, but shows the deflated index, using U.K. inflation data from Dimson, Marsh, and Staunton (2009).

[Insert Table 1 and Table 2 about here]

Table 1 reveals that decreases in the nominal price level occur rarely. In only four years do we see depreciations of 1% or more in the average catalogue prices: 1925 (–1.0%), 1981 (–1.8%), 1982 (–8.8%), and 1992 (–1.2%). However, our index sometimes remains remarkably stable over relatively long time periods, such as 1949–1957 or 1983–1994. That the return distribution shows a clustering just above zero—we find nominal returns of 0% to 1% in 28 years—suggests downward stickiness in prices. Stoller (1984) argues that in collectibles markets, a lowered demand will lead to a decrease in the number of transactions rather than in the price level, due to sellers' aversion to nominal losses. Case and Shiller (1988) show evidence of price rigidity in bear markets in real estate, where it can sometimes be explained by optimism about future prices. In our case, strategic considerations by Stanley Gibbons may also cause asymmetric price adjustments to changes in demand: a dealer may indeed be reluctant to undertake a downward revision in prices. However, as

[3] The confidence bounds around our parameter estimates are tight, except in the first decade of our time frame. Over the last half century, the 95% confidence interval for the yearly return is never wider than 0.50 percentage points.

long as the catalogue values still determine the dealer's *bids* and *asks*, downward price stickiness does not affect our results. Therefore, we do not explore this issue further here, although we will take into account (more general) appraisal smoothing and slow price adjustment when evaluating the total and systematic risk of stamp investments.

We see strong nominal price increases over several time frames, for example at the start of the twentieth century, in the second half of the 1960s, throughout the 1970s, and in the 2000s. Over the entire 109 years, the annualized return on our nominal price index is 7.0%.[4]

Table 2 shows that there have been several prolonged periods of price depreciation in real terms, for example in the 1910s, the 1950s, and between year-ends 1980 and 1994 (except in 1987). In contrast, we record the strongest price appreciations in the highly inflationary second half of the 1970s, when stamp prices increased more than threefold in real terms. We also observe large increases in value since the start of the new century. Our deflated stamp price index implies an average yearly real return of 2.9% over the 1899–2008 time frame.

We now compare the returns on our index with the returns on the (back-tracked) SG GB30. The period we examine runs from the end of 1973 (the first year for which prices for all constituents of the SG GB30 are available) to the beginning of 2004 (the year of creation of the SG GB30). If the Stanley Gibbons price index suffers from a look-ahead bias, we would expect it to overestimate the true historical returns on stamps, just like back-fitted equity indexes (Dimson, Marsh, and Staunton, 2002). Somewhat surprisingly, the geometric average nominal return on the back-tracked SG GB30 is in line with that of the repeat-sales index constructed in this study: 10.4% (SG GB30) versus 10.7% (our index). This implies that the SG GB30, although ad hoc in its design and clearly launched at the start of a stamp price boom, still gives a good idea of the average stamp price evolution since the beginning of the 1970s. However, if we want to get a truly long-term perspective on the returns from collectible stamps, and compare these returns to those on a number of other assets, the SG GB30 will not suffice.

[4] Repeating our analysis with an equal-weighted arithmetic repeat-sales methodology results in a very similar index, and an annualized return of 7.6%. Assuming no value impairment for stamps omitted from the catalogue results in an average return that is only 0.02% higher than when assuming a loss in value of 90%.

4.2. Stamps versus other assets

Now that we have established a 109-year history of the returns on British collectible postage stamps, we can compare these returns with those on U.K. Treasury bills, government bonds, and equities. The return data for these financial asset classes are from Dimson, Marsh, and Staunton (2009). The real price evolutions since year-end 1899 are shown in Figure 4.

[Insert Figure 4 about here]

Figure 4 shows that equities have outperformed all other asset categories, including stamps, over the period 1900–2008. Equities have realized a yearly average real return of 5.1%, while our stamp price index has grown by an annualized 2.9% in real terms. However, over the very long term, stamps have enjoyed higher returns than bonds or bills, which record average real returns of less than 1.5%. Even before the stamp price boom in the 1970s, our stamp index has a higher value than the indexes of bonds and bills. The successive negative real returns in the 1980s indicate, however, that stamps can also significantly underperform financial assets.

In Figure 5, we compare our stamp price index to the prices of two other physical assets for which long-term data are available, namely art and gold. Art is one of the most important categories of collectibles. Goetzmann, Renneboog, and Spaenjers (2011) provide us with an art index until 2007. Other art price indexes exist, but the one used here is the only one that gives information on the long-term returns in the British art market. The data from Goetzmann, Renneboog, and Spaenjers (2011) are chain-linked to one year of returns based on the U.K. art market index of Artprice.com (2010) to get an index until end-2008. The most striking difference between the art and the stamp price index is probably that there was a boom in stamps (but not in art) in the 1970s, and a boom in art (but not in stamps) in the 1980s. Also in 2008 the returns differ dramatically: our stamp index increased by about 35%, while art prices dropped by more than 20%. Nevertheless, over the complete period, the art index has an annualized real return that is only 0.5% below that of stamps. Next, we look at gold, using prices in GBP from Global Financial Data. The geometric average real return on gold is 0.7%, which is much less than the return on stamps. However, there is a remarkable similarity in the price pattern of gold and stamps over time—consider, for example, the price run-up over the 1970s, and the long decline afterwards. This is probably no coincidence. In the inflationary 1970s, real assets became attractive as hedges, and therefore showed relatively high returns (Ibbotson and Brinson, 1993). We more formally compare the hedging ability of stamps, “paper gold” according to Wagenheim (1976), to that of other assets in the next subsection.

[Insert Figure 5 about here]

A full overview of the distribution of the nominal and real returns on stamps, the financial assets, art, and gold can be found in Table 3. The mean returns on both stamps and art are between the returns on bonds and the returns on equities, and the story is the same for Sharpe ratios. A dilemma when comparing the returns on collectibles with those on financial securities lies in the differences in transaction costs and average holding periods. We return to this issue at the end of Section 4. Table 3 also shows that both stamps and art had their lowest real return in 1915, while both stamps and gold performed best in 1979, again hinting at some common factors driving the returns on these assets.

[Insert Table 3 about here]

At first sight, the standard deviation of stamp returns seems higher than that of bonds in nominal terms, but lower in real terms. We are, however, underestimating the true standard deviation of stamp returns, for a number of reasons. First, appraisals of an infrequently traded item’s value are typically sticky: they depend on previous price observations and are only partially adjusted in any period. The return series is therefore prone to ‘appraisal smoothing’ (Geltner, 1991). Second, and closely related, since the index is an average of time-ordered values, the first differences in index levels can be expected to be autocorrelated. The return series will therefore suffer from the ‘Working effect,’ which includes variability that is underestimated (Working, 1960; Schwert, 1990). Third, in 11 years, we use geometrically interpolated index values, which again smoothes the stamp return series.

A remedy for appraisal smoothing is to unsmooth the return series, a technique originated in the real estate literature (Ross and Zisler, 1991; Geltner, 1993), but later also applied to hedge funds (Kat and Brooks, 2002) and art market returns (Campbell, 2008). If we assume that all items are reappraised at the end of each period, the observed (or smoothed) return in period t, R_t , can be expressed as a weighted average of the true (underlying, unsmoothed) return in period t, R_t^u, and the smoothed return in the previous period, R_{t-1} (Geltner, 1993):

$$R_t = (1-\alpha)R_t^u + \alpha R_{t-1}. \quad (1)$$

Equation (1) can be inverted to recover the unsmoothed return series from the observed returns:

$$R_t^u = (R_t - \alpha R_{t-1})/(1-\alpha). \quad (2)$$

Inspection of the (partial) autocorrelogram suggests that the original real stamp return series follows an AR(1) process. This was confirmed by an analysis of the residuals using Portmanteau statistics. When the smoothed series follows an AR(1) process, one can set the coefficient α in Equation (2) equal to the autocorrelation coefficient at lag 1. By construction, the newly constructed series will then have a first-order autocorrelation that is close to zero, and the standard deviation of this unsmoothed return series is a better estimate of the true riskiness of stamp investments.

The first-order autocorrelation coefficients and the standard deviations of the smoothed and unsmoothed real returns are compared in Table 4. We lose the first observation when unsmoothing the stamp return data, so we also calculate the standard deviations of the returns on financial assets excluding the first return. Table 4 compares the standard deviations of stamps and financial assets on this basis.

[Insert Table 4 about here]

We see that the unsmoothed stamp return series has a standard deviation that is equal to 18.0%, which is 5.5% higher than the standard deviation of the original series, and also higher than that of the returns on bonds. To accommodate concerns about our interpolation of returns (and thus smoothing the index) in the first half century of our time frame, Table 4 also repeats the analysis for the real return series after 1951, which is the last year with an interpolated return. The unsmoothed real stamp returns now have a standard deviation of 19.7%, which is again much closer to the standard deviation of stock returns than bond returns. It is thus clear that the real riskiness of stamp investments, as measured by the volatility of returns, is probably not much different from that of investments in equity markets. Also note that there have been extended periods of real price depreciation, further decreasing the appeal of stamps to investors who do not have a long investment horizon.

4.3. Stamps, equity markets, and inflation

Table 5 presents pairwise correlation coefficients between stamps and the assets from the previous subsection, based on real and nominal returns. We also recalculate the correlations using the unsmoothed stamp returns, but the results (not reported) are very similar. The nominal returns on stamps are significantly positively correlated with the returns on bills, art, and gold. The real returns are positively correlated with bonds, bills, and gold, but not with equities or art. Furthermore, we see a positive correlation between nominal stamp returns and inflation, but a negative correlation between real stamp returns and inflation. In the remainder of this subsection, we first examine the equity market sensitivity of stamps; we then focus on the inflation hedging attributes of stamps.

[Insert Table 5 about here]

The lack of correlation between stamp and equity returns in Table 5 may be due to the non-synchronous nature of the two types of returns. This non-synchroneity problem stems from three different sources. First, stamp prices probably adjust slowly to changes in financial-economic conditions. Second, catalogue prices partially reflect prior periods' pricing history, as mentioned before. Third, in order to calculate yearly stamp returns, we assign all published catalogues to the closest year-end. This gives rise to a small discrepancy between the reported price trends of stamps and the timing of equity returns.

To gain more insight into the true equity market sensitivity of stamps, we therefore estimate the market model beta using the aggregated coefficients methodology of Dimson (1979), which accounts for non-synchroneity in asset returns. Dimson (1979) first runs a regression of asset returns on lagged, matching, and leading market returns:

$$R_t = \sum_{i=-a}^{b} \beta_i R_{t+i}^m + \upsilon_t, \tag{3}$$

where a is the number of lagged market returns, and b indicates the number of leading market returns. The slope coefficients are then aggregated to get an unbiased estimate of the beta of an asset:

$$\beta = \sum_{i=-a}^{b} \beta_i. \tag{4}$$

The results for our series of real stamp and equity (market) returns are shown in Table 6.

[Insert Table 6 about here]

Although the traditional beta (estimated in Model 1) is very close to zero, we get a significantly positive beta of 0.222 when also including one lag and one lead in the analysis (Model 2), with a β_{-1} equal to 0.141, indicating that it is mainly lagged equity market movements that matter. This beta grows to 0.325 with two lags and one lead (Model 3). These results show that there is non-negligible positive correlation between equity returns and stamp returns, but that the systematic risk of stamps is still relatively low. The low beta of stamps is consistent with the observation that the financial crisis did not stop stamp prices from rising during the 2008 bear market.

We now turn from the relation between equity markets and stamps to that between stamps and inflation. The correlation matrix in Table 5 shows a significantly positive correlation of 0.285 between the nominal returns on stamps and inflation. Only bills have a larger correlation coefficient (0.403). Art and gold seem to hedge at least partially against inflation as well. Stamps and other real assets thus appear to thrive in highly inflationary environments. However, when considering real returns on stamps, we see a significantly negative correlation with inflation of –0.263, a coefficient that is comparable to the correlation between equities or art and inflation. This finding is somewhat surprising given that we observed the largest real returns on stamps in the 1970s, when inflation was very high. Table 5 also shows that the real returns on all other assets except gold are significantly negatively correlated to inflation.

We further examine the hedging ability of stamps by relating stamp returns to measures for anticipated and unanticipated inflation. Our analysis follows similar studies in real estate, such as Liu, Hartzell, and Hoesli (1997). To initiate our analysis, we need a proxy for expected inflation that is available over the very long term. We consider two possibilities. First, we include lagged short-term interest rates in our analysis. Fama (1975) shows that if the T-bill market is efficient, and if the expected real return on bills does not change, changes in the nominal interest rate should be due to changes in the expected rate of inflation. Global Financial Data provides us with yields on one-year government notes since 1979; before then, we use annualized rates on three-month bills, measured at the previous year-end. A second, more naïve, measure is lagged inflation, which takes the value of inflation in the preceding year. Both proxies enable a measurement of the expected inflation rate in year t at the end of year t–1, expressed as $E(\Delta_t)$. Following Fama and Schwert (1977), we test the effectiveness of these two proxies as predictors of inflation through the following model:

$$\Delta_t = \alpha + \beta E(\Delta_t) + \varepsilon_t, \tag{5}$$

where Δ_t is the true inflation rate, measured at the end of year t. If β is close to unity (and α is close to zero), the measure of expected inflation is a good one. The error term then reflects the unexpected component of the observed inflation. The estimation of Equation (5), for our two proxies of anticipated inflation, is shown in Table 7.

[Insert Table 7 about here]

Table 7 shows that short-term interest rates are a reasonably good predictor of inflation. The α is statistically indistinguishable from zero, while β is only significantly different from one at the 10% level. However, as a robustness check, we also use lagged inflation as a measure of expected inflation. Although β is significantly smaller than unity for this proxy, we get a higher R-squared in the estimation of Equation (5).

We now test whether stamps (and other assets) are a hedge against expected and unexpected inflation using the methodology of Fama and Schwert (1977). Their model is the following:

$$R_{jt} = \alpha_j + \beta_j E(\Delta_t) + \gamma_j [\Delta_t - E(\Delta_t)] + \eta_{jt}, \tag{6}$$

where R_{jt} is the nominal rate of return on asset j, $E(\Delta_t)$ is the expected inflation rate, and $\Delta_t - E(\Delta_t)$ is the unanticipated inflation rate. An asset is a hedge against anticipated inflation if β_j is equal to one, while it is a hedge against unexpected inflation if γ_j is equal to one. The estimation results of Equation (6), using short-term interest rates and past inflation as proxies for expected inflation, can be found in Table 8.[5]

[Insert Table 8 about here]

Table 8 shows that stamps hedge against expected inflation, independent of the proxy used for inflationary expectations.[6] Equities and gold also seem to hedge against expected inflation, while the evidence is mixed for other asset classes. With respect to unexpected inflation, we only find strong support in favor of a hedging ability in the case of gold, although art is not significantly different from zero when lagged inflation is used. Since there may again be a non-synchroneity issue in the measurement of returns and unanticipated inflation rates, we repeat our Fama-Schwert tests using Dimson's aggregated coefficients methodology to investigate the true sensitivity of

[5] We also experimented with univariate autoregressive integrated moving average (ARIMA) models to predict inflation, but the forecasting power of these models was generally low. An alternative to the methodology of Fama and Schwert (1977) is the Fisherian direct causality equation of Solnik (1983), which replaces the nominal returns in Equation (6) by real returns, and replaces the unanticipated inflation by the change in expected inflation. Solnik's model is motivated by the argument of Geske and Roll (1983) that unanticipated inflation is only a proxy for changes in inflationary expectations. The results of this model show mixed evidence that stamps hedge against changes in inflationary expectations, dependent on the proxy for expected inflation. Details are available from the authors on request. All regressions were also repeated with Newey-West standard errors that allow for heteroskedasticity and autocorrelation in the error terms. However, this did not alter our conclusions.

[6] If dealers condition their price adjustments on realized inflation in the previous period, stamps will partially hedge against "expected inflation" by construction, at least when past inflation is used as a proxy for inflationary expectations.

stamp returns to unexpected inflation.[7] We include one lagged and one leading term, and now find coefficients on γ that are not significantly smaller than one at the 10% level. This indicates that stamps hedge at least partially against the unanticipated component of inflation as well.

4.4. The impact of transaction costs

The transaction costs associated with buying and selling rare British stamps amount to approximately 25% on a round-trip. Indeed, one can buy stamps at catalogue prices through Stanley Gibbons, while the company indicates a buy-back price of about 75% of catalogue value, and sometimes even enters into a contract to pay this price. Similarly, when trading through auction, one has to take account of the buyer's premiums and seller's commissions, which can add up to more than 20% of the underlying item's value. Stamps experience long holding periods (though this must be partly endogenous, since high transactions costs presumably curtail trading volume). Considering the long holding periods for stamp collections and the short holding periods for equity investment (Barber and Odean, 2000), the transaction cost drag associated with an investment-quality stamp collection may actually be similar to that of an equity portfolio.

To develop after-cost estimates of average returns on stamps and equities, we correct the baseline nominal geometric mean returns from Table 3 for annualized transactions costs. For stamps, we assume a transaction cost at sale of 25%. We ignore custody costs, which are low for stamps. Commissions on buying and selling equities on the London Stock Exchange (LSE) have fluctuated over time, with an average for small transactions of 1.75% and for large transactions of 0.45%; in addition, the U.K. levies stamp duty on equity purchases, and this tax averages 0.92% over our sample interval.[8] Time series of effective trading spreads are not available for Great Britain, so we proxy them with Jones' (2002) estimates of bid-ask spreads for Dow Jones Industrial Average (DJIA) index constituents, which average approximately 0.5% for a round-trip. The estimated one-way cost of equity trading is therefore the commission plus half the stamp duty plus half the spread,

[7] Non-synchroneity is less of a problem when examining the relation between stamp returns and expected inflation, because the expected inflation rate shows more persistence over time. Fama and Schwert (1977) follow a similar reasoning when considering the relation between real estate returns and inflation.

[8] Green, Maggioni, and Murinde (2000) report percentage marginal commission rates for small LSE transactions of 2.50 (1900–09), 1.25 (1910–17), 2.08 (1918–51), 1.39 (1952–59), 1.25 (1960–75), 1.50 (1976–81), and 1.65 (1982–86), a rate we assume persists after the 1986 deregulation. Rates for large transactions are 0.50 (1900–51), 0.75 (1952–59), 1.25 (1960–68), 0.50 (1969–70), and 0.125 (1971–86), which we also assume persists. The percentage rates of stamp duty are 0.5 (1900–46), 2.0 (1947–62), 1.0 (1963–73), 2.0 (1974–83), 1.0 (1984–85), and subsequently 0.5.

namely between 1.16% and 2.46%, depending on the size of the transaction. We ignore management fees and custody costs. Figure 6 shows the resulting annual post-cost return estimates for stamps and equities for holding periods ranging from one year to 40 years.

[Insert Figure 6 about here]

Figure 6 reveals that, as a historical average, a stamp investor needs to hold on to his stamps for more than four years to expect a positive return. Data on actual holding periods for stamps are hard to obtain, but there are sources on holding periods for art. An analysis of all resales within Reitlinger (1961) over the period 1760–1960 yields an average period between purchase and sale of 40 years. Despite some reservations about Reitlinger's data (Guerzoni, 1995), we regard 40 years as a reasonable estimate of the holding period for lifelong and cross-generational stamp collectors. With such a holding period, the mean yearly return on stamps net of transaction costs is 6.2%. (After ten and 25 years, the annualized after-cost returns are 3.9% and 5.8%, respectively.) A long investment horizon is particularly necessary given that stamps can also depreciate in real value over many successive years, as shown earlier.

The average holding period for equities is much shorter. If we assume an annualized turnover that averages 75% of market capitalization, based on Dimson and Marsh (1993–2009) and Jones (2002),[9] the mean yearly post-cost return for equities equals 5.2% (or 7.3%, if transaction costs are small). Consistent with Barber, Lee, Liu, and Odean (2009), stock market investors thus lose a meaningful proportion of their wealth through trading, and it is clear that before-cost returns do not tell the whole story. If the average stamp investor retains his collection for a long interval, he can earn returns that are similar to those of the average equity investor (but below those of a buy-and-hold equity investor).

5. Conclusions and discussion

More than a century ago, journalist and stamp collector Edward Nankivell (1902) argued that "it is impossible to get away from the necessity of regarding stamps as an investment." Today it is no longer taboo to think of stamps as an asset that may contribute to a diversified investment portfolio.

[9] Dimson and Marsh (1993–2009) report quarterly equally weighted (EW) and market value-weighted (VW) averages for the turnover of British equities. Over 1993–2009, the mean EW average was 74.5% (standard deviation 91.9%), while the mean VW average was 89.5% (standard deviation 74.3%). For earlier periods, Jones' (2002) estimate of DJIA turnover is, on average, close to these levels, though with considerable time series fluctuation.

Especially when the economic environment is uncertain or inflation runs high, collectibles can seem an attractive and relatively safe investment asset. In this paper, we have looked into the returns on British collectible stamps over the very long run. Since 1900, our price index of classic stamps has appreciated at a yearly average rate of 7.0% in nominal terms, which is equivalent to a real return of 2.9%. This is lower than the return on equities, but higher than bonds and bills. There have been some booms in the stamp market (in nominal and real terms), most notably in the second half of the 1970s, and in recent years. However, during most of the 1980s, and well into the 1990s, our index has shown negative real returns.

After unsmoothing the stamp return series, we find that the standard deviation of real returns is higher than that of bonds, and relatively close to equities. After accounting for non-synchroneity in the returns of stamps and equities, we conclude that there is a positive correlation between real equity and stamp returns, but that the beta of stamps is still relatively low. We find strong evidence that stamps hedge against expected inflation, and weaker support for the hypothesis that stamps also hedge against unanticipated inflation. When taking into account differences in holding periods and in transaction costs, we find that the realized returns on stamps and equities may be closer to each other than one might conclude at first sight.

As an alternative asset class, stamps have characteristics that are clearly different from those of stocks or other financial securities. Just like other collectibles, stamps do not give rise to future cash flows, on which the valuation of traditional assets is based. It is still unclear what drives the returns on collectibles. This paper has hinted at the existence of a wealth effect: there is a positive correlation between the returns on equities and those on stamps. It has also documented the use of stamps as a hedge in highly inflationary environments. However, other factors may determine the long-term price performance of collectibles. For example, if the stock of stamps slowly deteriorates over time, prices may be modeled in a framework comparable to that of Hotelling (1931) and Jovanovic (2007), who study non-renewable resources. The long-term returns of British art and stamps are similar, though these two asset return series appear to move in waves, with marked deviations over intermediate periods. We hope that the length and consistency of construction of our index series will facilitate further research on the factors that determine the prices of collectibles.

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Table 1—Stamp price index values and nominal returns 1899–2008

Table 1 reports the index values of our stamp price index from 1899 until 2008. The index is estimated by applying a value-weighted arithmetic repeat-sales regression (Shiller, 1991) to our database of catalogue prices (in GBP) of British stamps. We consider each edition of the Stanley Gibbons price catalogue between year-end 1899 (edition 13) and year-end 2008 (edition 111). The index is set equal to 100 at the beginning of 1900. Year-ends, around which no catalogue was published, and for which nominal index values are therefore interpolated, are indicated by asterisks. The table also shows yearly nominal returns.

Year-end	Index	Return	Year-end	Index	Return	Year-end	Index	Return
1899	100.0	-	1936	432.8	1.6%	1973	3,644.7	19.0%
1900 *	109.6	9.6%	1937	443.4	2.4%	1974	4,327.5	18.7%
1901	120.0	9.6%	1938	447.1	0.8%	1975	5,933.8	37.1%
1902	137.1	14.2%	1939	455.2	1.8%	1976	10,542.3	77.7%
1903	152.2	11.0%	1940	455.5	0.1%	1977	14,349.5	36.1%
1904	164.7	8.2%	1941	469.0	3.0%	1978	18,556.5	29.3%
1905 *	165.6	0.5%	1942 *	504.5	7.6%	1979	33,994.0	83.2%
1906	166.5	0.5%	1943	542.7	7.6%	1980	42,093.8	23.8%
1907	169.4	1.8%	1944	582.3	7.3%	1981	41,340.6	-1.8%
1908	170.0	0.4%	1945 *	643.0	10.4%	1982	37,713.5	-8.8%
1909 *	171.1	0.6%	1946	710.0	10.4%	1983	37,445.4	-0.7%
1910	172.1	0.6%	1947 *	766.5	8.0%	1984	37,490.4	0.1%
1911	176.2	2.3%	1948	827.5	8.0%	1985	37,568.2	0.2%
1912	178.6	1.4%	1949	834.2	0.8%	1986	37,723.8	0.4%
1913	177.6	-0.5%	1950 *	834.0	0.0%	1987	39,256.9	4.1%
1914	192.0	8.1%	1951	833.9	0.0%	1988	39,703.1	1.1%
1915	190.3	-0.9%	1952	839.3	0.7%	1989	40,392.9	1.7%
1916 *	191.0	0.3%	1953	844.6	0.6%	1990	40,543.5	0.4%
1917	191.6	0.3%	1954	845.2	0.1%	1991	40,743.0	0.5%
1918 *	196.2	2.4%	1955	845.2	0.0%	1992	40,236.2	-1.2%
1919	200.9	2.4%	1956	851.2	0.7%	1993	40,276.9	0.1%
1920	218.2	8.6%	1957	856.2	0.6%	1994	40,537.4	0.6%
1921 *	229.0	5.0%	1958	873.1	2.0%	1995	42,807.0	5.6%
1922	240.5	5.0%	1959	906.7	3.9%	1996	44,319.4	3.5%
1923 *	243.7	1.3%	1960	1,021.5	12.7%	1997	44,319.4	0.0%
1924	247.0	1.3%	1961	1,079.4	5.7%	1998	47,020.6	6.1%
1925	244.6	-1.0%	1962	1,154.4	7.0%	1999	49,489.6	5.3%
1926	244.1	-0.2%	1963	1,165.0	0.9%	2000	55,706.1	12.6%
1927	274.1	12.3%	1964	1,177.4	1.1%	2001	57,163.6	2.6%
1928	299.2	9.2%	1965	1,464.7	24.4%	2002	62,740.4	9.8%
1929	329.7	10.2%	1966	1,586.0	8.3%	2003	72,278.6	15.2%
1930	347.2	5.3%	1967	1,666.1	5.0%	2004	85,706.7	18.6%
1931	354.0	2.0%	1968	1,703.2	2.2%	2005	94,699.8	10.5%
1932	364.1	2.8%	1969	2,699.2	58.5%	2006	104,703.3	10.6%
1933	374.4	2.8%	1970	2,943.6	9.1%	2007	114,952.5	9.8%
1934	421.6	12.6%	1971	2,988.6	1.5%	2008	155,810.1	35.5%
1935	425.9	1.0%	1972	3,063.8	2.5%			

Table 2—Deflated stamp price index values and real returns 1899–2008

Table 2 reports the deflated index values of our stamp price index from 1899 until 2008. The index is obtained by correcting the nominal index values from Table 1 for inflation, using data from Dimson, Marsh, and Staunton (2009). The index is set equal to 100 at the beginning of 1900. The table also shows yearly real returns. Year-ends, around which no catalogue was published, and for which nominal index values are therefore interpolated in Table 1, are indicated by asterisks.

Year-end	Index	Return	Year-end	Index	Return	Year-end	Index	Return
1899	100.0	-	1936	246.6	-1.0%	1973	455.2	7.6%
1900 *	107.3	7.3%	1937	238.4	-3.3%	1974	453.7	-0.3%
1901	116.4	8.5%	1938	246.6	3.4%	1975	498.1	9.8%
1902	131.6	13.0%	1939	226.4	-8.2%	1976	769.0	54.4%
1903	144.7	10.0%	1940	200.9	-11.2%	1977	933.4	21.4%
1904	156.6	8.2%	1941	200.8	-0.1%	1978	1,113.6	19.3%
1905 *	158.2	1.0%	1942 *	217.0	8.1%	1979	1,740.1	56.3%
1906	156.6	-1.0%	1943	234.6	8.1%	1980	1,871.8	7.6%
1907	154.9	-1.1%	1944	249.3	6.2%	1981	1,640.6	-12.4%
1908	153.2	-1.1%	1945 *	272.5	9.3%	1982	1,419.8	-13.5%
1909 *	153.4	0.2%	1946	299.4	9.9%	1983	1,338.6	-5.7%
1910	152.9	-0.4%	1947 *	313.2	4.6%	1984	1,281.5	-4.3%
1911	152.9	0.0%	1948	322.4	2.9%	1985	1,215.1	-5.2%
1912	152.3	-0.4%	1949	314.0	-2.6%	1986	1,176.3	-3.2%
1913	152.1	-0.1%	1950 *	304.2	-3.1%	1987	1,180.6	0.4%
1914	150.1	-1.3%	1951	271.4	-10.8%	1988	1,118.2	-5.3%
1915	121.3	-19.2%	1952	256.8	-5.4%	1989	1,056.2	-5.5%
1916 *	99.6	-17.9%	1953	255.8	-0.4%	1990	969.5	-8.2%
1917	89.1	-10.5%	1954	246.2	-3.7%	1991	932.7	-3.8%
1918 *	76.7	-13.9%	1955	232.6	-5.5%	1992	897.9	-3.7%
1919	76.8	0.1%	1956	227.3	-2.3%	1993	881.8	-1.8%
1920	69.8	-9.1%	1957	218.5	-3.9%	1994	862.5	-2.2%
1921 *	99.0	41.9%	1958	218.8	0.1%	1995	882.4	2.3%
1922	114.9	16.1%	1959	227.2	3.9%	1996	891.6	1.0%
1923 *	118.4	3.1%	1960	251.5	10.7%	1997	860.4	-3.5%
1924	117.4	-0.9%	1961	254.6	1.2%	1998	888.4	3.3%
1925	118.8	1.2%	1962	265.3	4.2%	1999	918.9	3.4%
1926	117.3	-1.3%	1963	262.8	-0.9%	2000	1,004.9	9.4%
1927	139.5	18.9%	1964	253.4	-3.6%	2001	1,024.0	1.9%
1928	153.2	9.8%	1965	301.7	19.0%	2002	1,091.8	6.6%
1929	169.9	10.9%	1966	315.1	4.4%	2003	1,223.5	12.1%
1930	192.7	13.4%	1967	323.1	2.5%	2004	1,401.9	14.6%
1931	205.8	6.8%	1968	311.8	-3.5%	2005	1,515.5	8.1%
1932	219.1	6.4%	1969	472.0	51.4%	2006	1,604.5	5.9%
1933	225.3	2.8%	1970	477.2	1.1%	2007	1,693.1	5.5%
1934	251.8	11.8%	1971	444.3	-6.9%	2008	2,273.3	34.3%
1935	249.2	-1.0%	1972	423.1	-4.8%			

Table 3—Distribution of returns on stamps and other assets 1900–2008

Table 3 reports the distribution of nominal and real returns for stamps and different U.K. asset classes over the period 1900–2008. For each asset category, it shows the geometric and arithmetic average return per annum (p.a.), the standard deviation (S.D.), and the lowest and highest recorded return. Finally, it also shows the ex post Sharpe ratios for stamps, equities, bonds, art, and gold, taking the returns on bills as a proxy for risk-free returns. The stamp return data are shown in Tables 1 and 2. The return data for equities, bonds, bills, and inflation come from Dimson, Marsh, and Staunton (2009). The return data for art come from Goetzmann, Renneboog, and Spaenjers (2011) and Artprice.com (2010). Gold prices are downloaded from Global Financial Data.

	Mean returns p.a.		Dispersion of annual returns					Sharpe
	Geometric	Arithmetic	S.D.	Lowest		Highest		
Nominal returns								
Stamps	7.0%	7.7%	13.7%	-8.8%	1982	83.2%	1979	0.196
Equities	9.2%	11.2%	21.8%	-48.8%	1974	145.6%	1975	0.281
Bonds	5.4%	6.0%	11.9%	-17.4%	1974	53.1%	1982	0.079
Bills	5.0%	5.1%	3.8%	0.5%	1946	17.2%	1980	-
Art	6.4%	7.3%	13.4%	-31.1%	1930	46.6%	1968	0.173
Gold	4.7%	6.1%	19.8%	-23.9%	1997	131.1%	1979	0.049
Inflation	4.0%	4.2%	6.6%	-26.0%	1921	24.9%	1975	-
Real returns								
Stamps	2.9%	3.6%	12.5%	-19.2%	1915	56.3%	1979	0.198
Equities	5.1%	7.0%	20.0%	-57.1%	1974	96.7%	1975	0.297
Bonds	1.4%	2.3%	13.7%	-30.7%	1974	58.9%	1921	0.094
Bills	1.1%	1.2%	6.3%	-15.4%	1915	42.3%	1921	-
Art	2.4%	3.2%	12.5%	-29.7%	1915	38.4%	1968	0.152
Gold	0.7%	2.0%	17.5%	-30.5%	1975	97.1%	1979	0.040

Table 4—Autocorrelations and standard deviations of real returns on stamps

Table 4 reports the first-order autocorrelation (AC) of the returns for the periods 1900–2008 and 1952–2008, and standard deviations (S.D.) of both the original and the unsmoothed real stamp return series for the periods 1901–2008 and 1953–2008. For equities, bonds, and bills, it also shows the standard deviation of the real return series for the periods 1901–2008 and 1953–2008. The original real stamp return data are shown in Table 2. The return data for equities, bonds, and bills come from Dimson, Marsh, and Staunton (2009).

	Since 1900		Since 1952	
	Original	Unsmoothed	Original	Unsmoothed
First-order AC of real stamp returns	0.349	-0.002	0.301	0.012
S.D. of real returns				
Stamps	12.5%	18.0%	14.5%	19.7%
Equities	20.1%		23.7%	
Bonds	13.8%		12.8%	
Bills	6.4%		3.4%	

Table 5—Correlation matrix of returns on stamps and financial assets 1900–2008

Table 5 reports the pairwise correlations of the nominal and real returns of stamps and different U.K. asset classes. It also includes the correlations with inflation. The correlation coefficients in italics are calculated based on real asset returns, while the others are based on nominal return data. The stamp return data are shown in Tables 1 and 2. The return data for equities, bonds, bills, and inflation come from Dimson, Marsh, and Staunton (2009). The return data for art come from Goetzmann, Renneboog, and Spaenjers (2011) and Artprice.com (2010). Gold prices are downloaded from Global Financial Data. ***, **, and * denote significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Stamps	Equities	Bonds	Bills	Art	Gold	Inflation
Stamps	-	0.005	0.086	0.314 ***	0.198 **	0.451 ***	0.285 ***
Equities	*0.004*	-	0.514 ***	0.176 *	0.196 **	-0.194 **	0.134
Bonds	*0.249* ***	*0.531* ***	-	0.291 ***	-0.005	-0.145	-0.062
Bills	*0.363* ***	*0.264* ***	*0.646* ***	-	0.312 ***	0.202 **	0.403 ***
Art	*0.138*	*0.217* **	*0.090*	*0.225* **	-	0.147	0.298 ***
Gold	*0.398* ***	*-0.184* *	*-0.023*	*0.149*	*0.059*	-	0.238 **
Inflation	*-0.263* ***	*-0.217* **	*-0.554* ***	*-0.821* ***	*-0.186* *	*-0.116*	-

Table 6—Market model regressions

Table 6 reports the results of the ordinary least squares (OLS) estimation of Equation (3), which relates real stamp returns to real U.K. equity market returns over the period 1900–2008. β aggregates the individual slope coefficients on a lagged market returns, the same-year market return, and b leading market returns into an unbiased estimate of the market model beta, using Dimson (1979). R^2 is the R-squared, or the multiple correlation coefficient. The real stamp return data are shown in Table 2. The return data for equities come from Dimson, Marsh, and Staunton (2009). ***, **, and * denote significantly different from zero at the 1%, 5%, and 10% level, respectively. All coefficients are significantly smaller than one.

	β_{-2}	β_{-1}		β_0	β_{+1}	β		R^2
Model 1 (a = 0 and b = 0)	-	-		0.002	-	0.002		0.000
Model 2 (a = 1 and b = 1)	-	0.141	**	0.042	0.038	0.222	**	0.056
Model 3 (a = 2 and b = 1)	0.079	0.148	**	0.052	0.046	0.325	**	0.074

Table 7—Effectiveness of inflation predictors

Table 7 reports the results of the OLS estimation of Equation (5), which relates the inflation rate to the ex ante prediction of inflation over the period 1900–2008. α is the intercept and β is the slope coefficient. The null hypothesis is that the proxy for expected inflation in the first column is an effective one. R^2 is the R-squared, or the multiple correlation coefficient. Data on short-term interest rates come from Global Financial Data. Inflation data come from Dimson, Marsh, and Staunton (2009).

	α	t-stat $H_0: \alpha = 0$	β	t-stat $H_0: \beta = 1$	R^2
Short-term interest rate	0.008	0.79	0.671	-1.93	0.127
Lagged inflation	0.020	3.12	0.510	-5.86	0.259

Table 8—Inflation hedging abilities of stamps and other assets

Table 8 first reports the results of the OLS estimation of Equation (6), which tests whether the assets hedge against expected inflation and unexpected inflation, over the period 1900–2008. The table shows the results for two proxies of expected inflation: short-term interest rates and lagged inflation. In each case, the null hypothesis is that of a good hedge. R^2 is the R-squared, or the multiple correlation coefficient. To further analyze the relation between the returns on stamps and unanticipated inflation, the analysis is also repeated for stamps using the aggregated coefficients methodology of Dimson (1979). In this case, we estimate γ by aggregating the slope coefficients on one lagged term, the same-year unanticipated inflation, and one leading term. The nominal stamp return data are shown in Table 1. Data on short-term interest rates come from Global Financial Data. The return data for equities, bonds, bills, and inflation come from Dimson, Marsh, and Staunton (2009). The return data for art come from Goetzmann, Renneboog, and Spaenjers (2011) and Artprice.com (2010). Gold prices are downloaded from Global Financial Data.

	Short-term interest rate					Lagged inflation				
	β	t-stat $H_0: \beta = 1$	γ	t-stat $H_0: \gamma = 1$	R^2	β	t-stat $H_0: \beta = 1$	γ	t-stat $H_0: \gamma = 1$	R^2
Baseline results										
Stamps	1.298	0.82	0.426	-2.84	0.126	0.769	-1.05	0.407	-2.67	0.104
Equities	1.619	1.04	0.158	-2.54	0.066	0.641	-0.99	0.222	-2.12	0.030
Bonds	1.335	1.15	-0.454	-8.95	0.249	0.082	-4.65	-0.317	-6.61	0.041
Bills	1.040	1.48	0.038	-64.02	0.935	0.319	-12.30	0.134	-15.50	0.241
Art	1.205	0.58	0.461	-2.73	0.122	0.549	-2.08	0.657	-1.57	0.091
Gold	1.157	0.29	0.603	-1.32	0.065	0.686	-0.96	0.731	-0.82	0.057
Aggregated coefficients methodology										
Stamps	1.327	0.90	0.636	-1.41	0.150	0.964	-0.14	0.548	-0.92	0.131

Figure 1—Number of catalogue entries and price trends 1865–1900

Figure 1 shows the number of regular British adhesive stamps in the 1865 Stanley Gibbons price list and in all catalogues published between 1879 (edition 1) and 1900 (edition 13). It also presents the total value in GBP of a portfolio that contains the eight used stamps for which prices are available in 1865, and the value of an unused Penny Black, in each edition. The horizontal axis shows the years of publication of the catalogues.

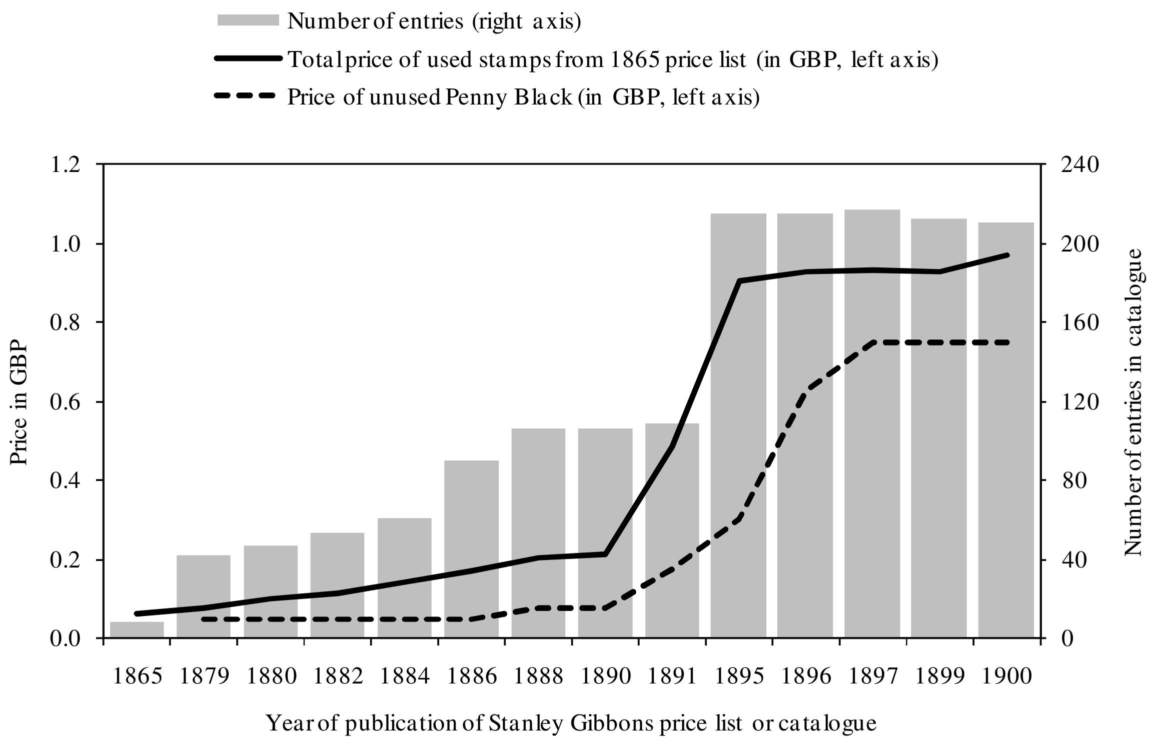


Figure 2—Illustrations of stamps: *SG 5* and *SG 121*

Figure 2 shows the two stamps that have consistently been among the top-50 of most valuable stamps in our database of British stamps over the time frame 1900–2008. © Stanley Gibbons.

SG classification no. *5*, 1840, 2d., blue (unused) SG classification no. *121*, 1880, 2s., brown (unused)

Figure 3—Number of observations and value of most / least valuable stamp for each edition

Figure 3 shows the total number of stamps in our sample, partitioned into the number of observed prices and the number of missing observations, for each edition of the Stanley Gibbons price catalogue between year-end 1899 (edition 13) and year-end 2008 (edition 111). It also presents the value in GBP of the most valuable stamp and least valuable stamp in our sample for every catalogue.

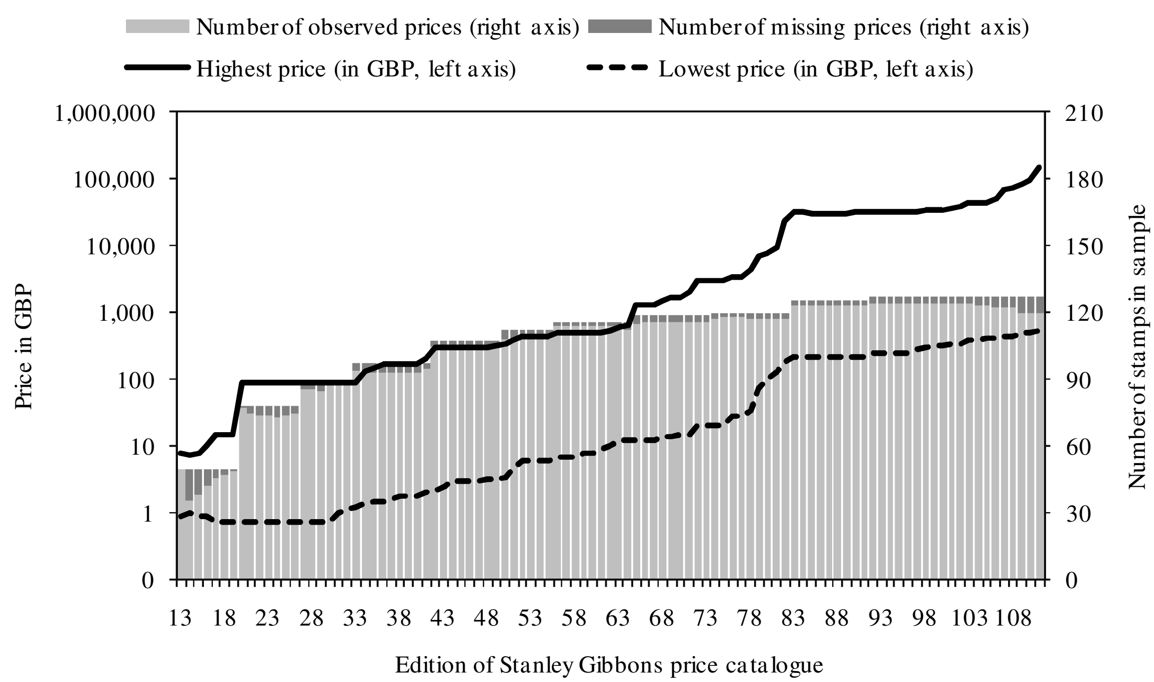


Figure 4—Cumulative returns on stamps and financial assets in real terms 1900–2008

Figure 4 shows the real (i.e., deflated) index values for U.K. stamps, equities, bonds, and bills over the time frame 1900–2008. It also presents the geometric average real return per annum (p.a.) for each asset category. The index is set equal to 100 at the beginning of 1900. The real stamp price index data are shown in Table 2. The return data for equities, bonds, and bills come from Dimson, Marsh, and Staunton (2009).

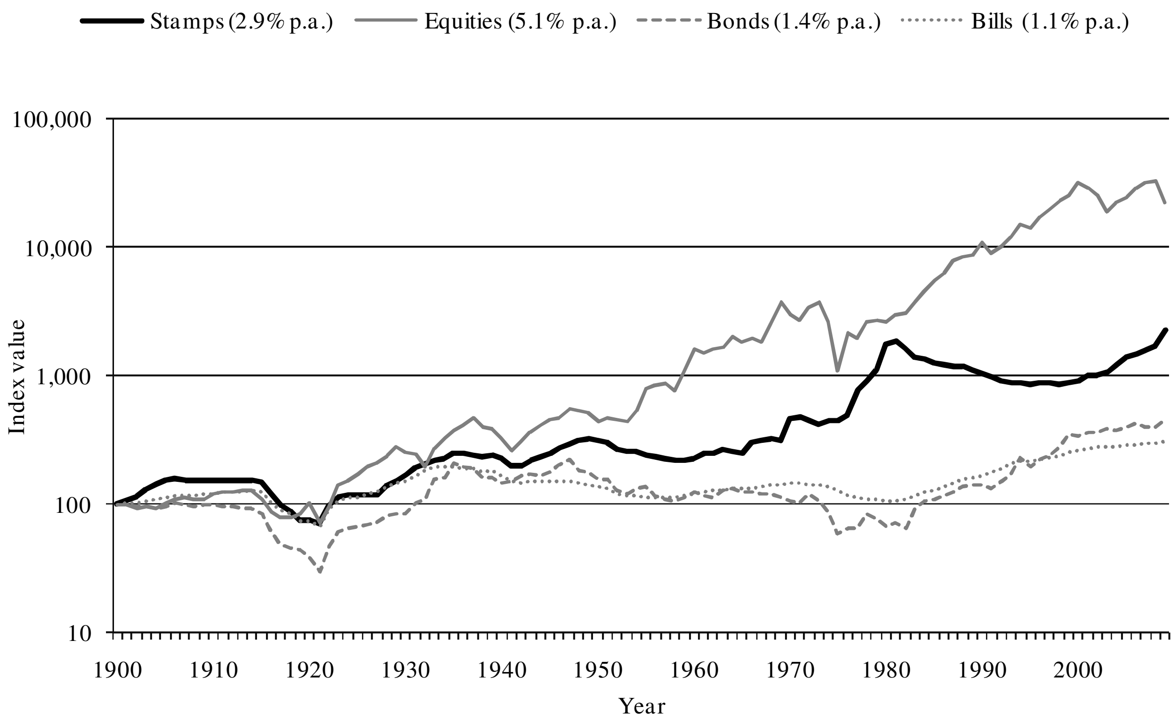


Figure 5—Cumulative returns on stamps and real assets in real terms 1900–2008

Figure 5 shows the real (i.e., deflated) index values for U.K. stamps, art works, and gold over the time frame 1900–2008. It also presents the geometric average real return per annum (p.a.) for each asset category. The index is set equal to 100 at the beginning of 1900. The real stamp price index data are shown in Table 2. The return data for art come from Goetzmann, Renneboog, and Spaenjers (2011) and Artprice.com (2010). Gold prices are downloaded from Global Financial Data.

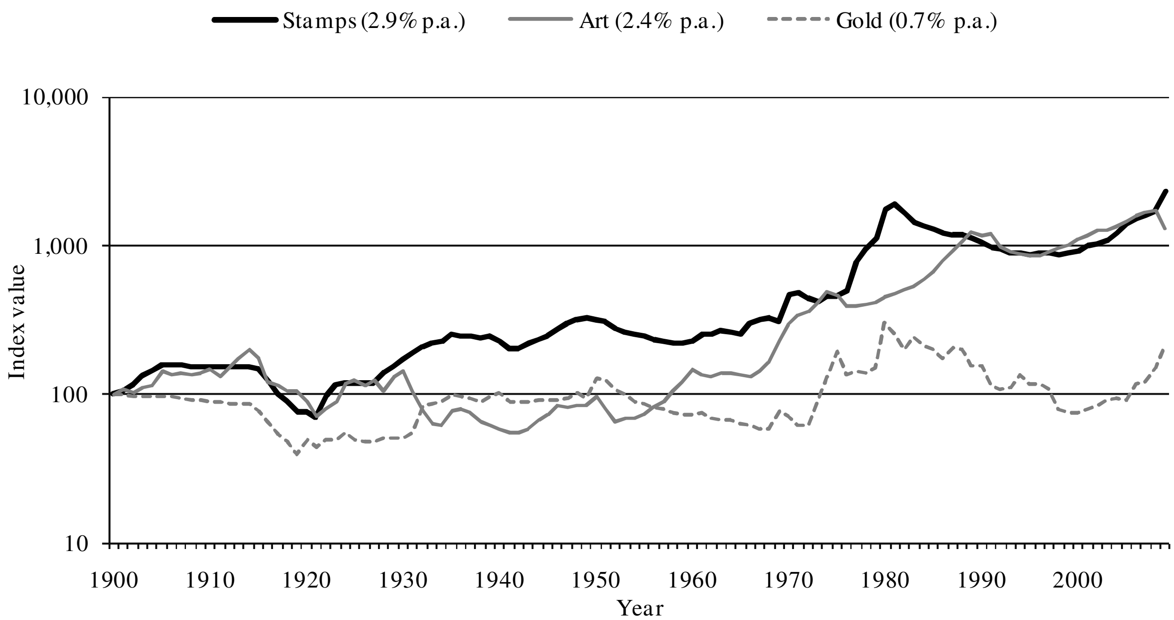
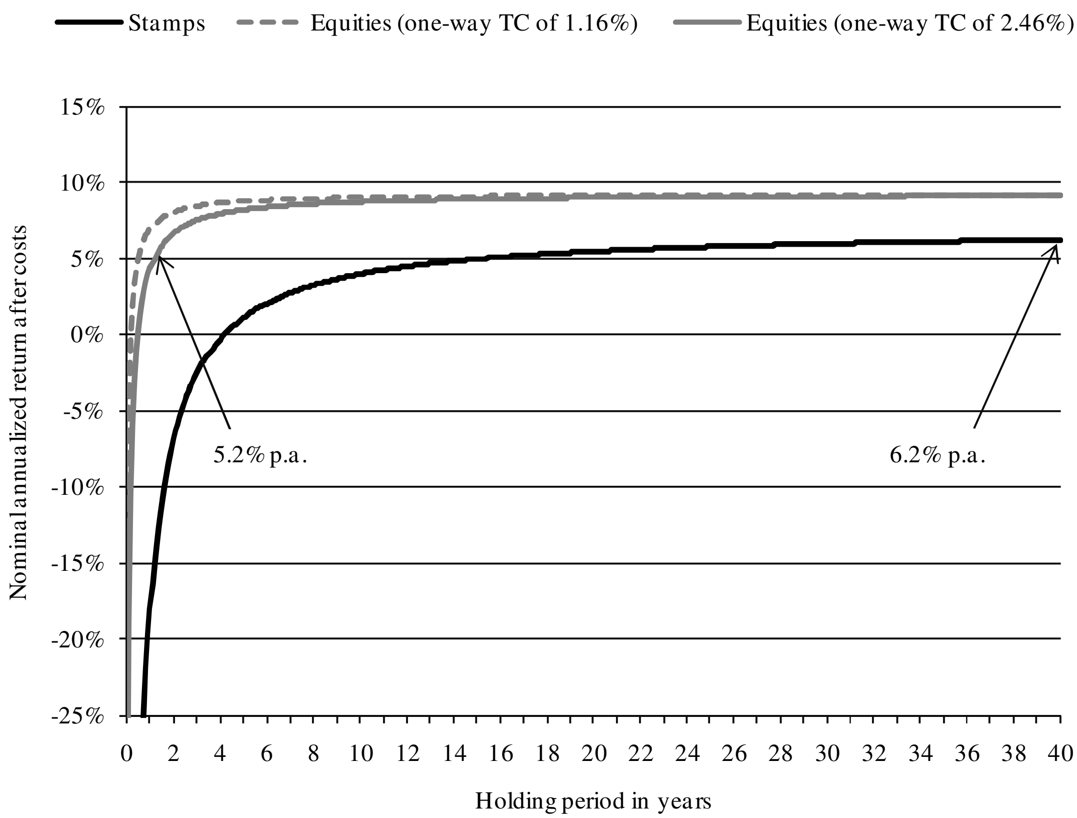


Figure 6—Estimates of annual post-cost returns on stamps and equities

Figure 6 shows the estimates of the nominal geometric mean returns on stamps and equities after costs, for holding periods between one year and 40 years. The post-cost returns are estimated correcting the baseline average returns (from Table 3) for annualized transaction costs. For stamps, we assume a transaction cost at sale of 25%. For equities, we assume one-way transaction costs (TC) of 1.16% and 2.46%. A motivation for these assumptions can be found in Section 4.



Chapter 7

Conclusion and avenues for future research

The previous chapters have looked into the returns and return determinants of art and stamps. The main findings of this dissertation are threefold. First, the long-run returns on collectibles have been positive, even after accounting for inflation. Chapter 2 showed that, worldwide, art prices have increased by about 4%, in real USD terms, between 1957 and 2007. In Chapter 3, we found that, in Great Britain, high-quality art appreciated at a real rate of 3.20% between 1830 and 2007. The analysis of the British stamp market in Chapter 6 showed real returns of almost 3% over the period 1900–2008. These returns are, however, substantially lower than those realized in the equity market, despite similar volatilities. Moreover, they do not take into account the elevated transaction costs that come with investments in "emotional assets".

Second, there exists substantial variation in investment performance across collecting categories and countries. Chapters 2 and 3 indicated that oil paintings, post-war art, masterpieces, and art from emerging markets outperformed other types of art over the last half century. Chapter 5 revealed important differences in the annualized returns between different art markets. Unreported research on the stamp price data used in Chapter 6 also showed variation in returns across quality categories, with a flight-to-quality taking place in recent years.

Third, despite claims of many alternative investment funds to the contrary, there is substantial correlation between the prices of collectibles on the one hand and macro-economic fundamentals on the other. This thesis has provided evidence that equity market wealth, the income distribution, inflationary expectations, and other economic variables matter in setting prices. However, the exposure to economic fundamentals again varies across collecting categories. I give a few examples. Chapter 3 demonstrated that oil prices have a bigger impact on the prices of Russian art than on a global art index. Chapter 5 illustrated that local (i.e., country-specific) economic growth and equity returns are much less important in setting art prices in more internationally-oriented markets and for higher-quality works. Chapter 6 showed that expectations of inflation drove up stamp prices in the late 1970s, while this was not a period of rising art prices. Stamps are of course cheaper to store, insure and transport than works of art, and may therefore be a more convenient hedge.

At the same time, the findings suggests a number of avenues for future research, which reflect the limitations of the current study. First, a deeper examination of the (time-varying) motives among the buyers of collectibles seems warranted. Finding out to which degree consumption dominates investment would be interesting in itself, but may also inform a theoretical framework that provides structure to the research on the determinants of returns in collectibles markets. It is still largely a puzzle how one should think about emotional assets in an asset pricing context—or in an expected utility model. This also implies that it is unclear whether traditional asset pricing risk factors play a role in setting collectibles prices or not.

Second, and related to the previous point, by focusing on income and wealth effects, this thesis has mainly examined how the demand for luxury consumption drives the prices of art and stamps. In this sense, one could see an investment in collectibles as a bet on future luxury consumption. However, collectibles markets may also be impacted by “sentiment” or “animal spirits” that have proven to be so important in other financial markets. The lack of knowledge on fundamentals and the absence of short-selling possibilities must make emotional asset markets particularly vulnerable to bubble-like behavior—even if it is hard to identify bubbles.

Third, several chapters relied on a hedonic regression technique to estimate returns in the art market. One drawback of the hedonic methodology is that no investable portfolio is identified. A more general concern is that it clearly is impossible to have a fully diversified art portfolio. Future work will therefore not only have to test the robustness of the presented results to a repeat-sales regression, but also shed more light on the performance of different implementable trading strategies.

Fourth, some of my research has touched upon differences in tastes across countries. However, most evidence on home bias in collectibles markets is indirect. Maybe auction house data or historical information can provide better insight on who buys what and where. Moreover, it would be interesting to examine whether tastes have become more integrated over time, and how this has affected the distribution of art prices (and the importance of local factors in setting those prices).

Fifth, the role of sample and survivorship issues in price index estimation deserves more attention. How representative (for the complete population of art works) is the art that is being sold at auction at any point in time? Why do we focus on paintings and stamps, but much less so on furniture, snuff-boxes, or tapestries? Is stylistic risk adequately captured by aggregate price indices? I leave these fascinating questions for future work.